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It is expected that such a commencement of such a work, will meet with that entire satisfaction from the subscribers, which will at once place sufficient, and secure adequate means of assistance and funds, at the disposal of the Committee, upon which the utmost consideration will be again given to the revision of this list, and the plan for carrying out the Cyclopædia efficiently and constantly, will be completely matured.

Synonyms in foreign languages, for the Polyglossary, will be acceptable; they are not included in the subjoined list, it being proposed to form them into a separate paper.

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PROPOSED TO BE INSERTED IN A

CYCLOPÆDIA OF ARCHITECTURE.

The References are to the following Divisions of the Art:—

ARCHÆOLOGY.	CONSTRUCTION.	ORNAMENT.
BIBLIOGRAPHY.	DECORATION.	PERSPECTIVE.
BIOGRAPHY.	GEOLOGY.	POLIOGRAPHY.
BOTANY.	HISTORY.	PRACTICE.
CHYMISTRY.	LANDSCAPE GARDENING.	THEORY.

Aaken, Jacob van Biog.
Aarhuus Polio.
Aaron's-rod, or Caduceus Dec.
Abaciscus
Abacot Decor.
Abaculus
Abacus
Abaiser
Abamurus
Abate Biog.
Abatement, or Batement
Abaton
Abat-jour
Abat-vent
Abat-voix
Abattoir
Abbattis, Abatis, or Abattis
Abbeville Polio.
Abbey
Abbot's lodging
Abbreviation
Abbuttals, or Abuttals
Abderites
Abel, John Biog.
Abele-tree, *see* Populus Bot.
Aberdeen (Devina Texalorum)
Aberration [Polio.
Aberthaw Lime
Abietineæ Bot.
Ability
Ablaqueation
Abnormal
Aboukir (Canopus) Polio.
Abousambul, Aboo-Simbel P.
Abousir (Busiris) Polio.
Abrantes
Abreuvoir, and in Masonry
Abraxas, Abracax Decor.
Abrupt
Absciss, or Abscissa
Absis, *see* Apsis
Absorbent
Absorbing well
Absorption
Abstract
Absurdity
Abury, *see* Avebury Polio.
Abuse
Abutment
Abuttals
Abydos Polio.
Acacia-tree, *see* Robinia Bot.
Academia
Academic
Academician
Academist
Academy
Acalus, or Calus Biog.
Acanthaceæ Bot.
Acapulco Polio.
Access
Accessory, or Accompaniment
Accident
Accidental Point Persp.
Acclivity
Accommodation
Accompaniment
Accompts
Accordance
Accouplement
Accubitus
Accumoli Biog.
Accuracy
Acerineæ Bot.
Aceric Acid
Acerra Decor.
Acetate
Achaia Polio.
Achelor, Ashiler
Achievement
Achleitner, Simon Biog.
Achmin Polio.
Achmounein (Hermopolis) P.
Achromatic
Acids
Acinose
Acme
Acorn Bot.
Acorus (Aroideæ) Bot.
Acoustics
Acquapendente Polio.
Acqui Polio.
Acradina Polio.
Acre
Acrolithos
Acropolis
Acrostolium
Acroterium, or Acroter
Act
Actinobilism
Actinometer
Action
Actus
Acute angle
Adage
Adam, J. Biog.
—— R. Biog.
—— W. Biog.
Adamant, or Diamond
Adams, B. Biog.
—— R. Biog.
—— P. Biog.
Adaptation
Addition
Adhesion
Adit, or Aditus
Adjacent Angle
Adjustment
Adjutage, or Ajutage
Admeasurement
Admiralty
Admiration
Adoption
Adorn
Adria (Atria) Polio.
Advance
Advice
Adytum
Adze, or Addice
Æcclesiola
Ædes
Ædicula
Ædiculus
Ægesta Polio.
Ægina (Egina) Polio.
Ægis Decor.
Ægricanes Decor.
Ægyci
Ægyptilia Decor.
Ælamoth
Ælbrechts Biog.
Ælfric Biog.
Ælia Capitolina Polio.
Æmilia Via
Æneatores Decor.
Æolia Polio.
Æolipylæ
Æolus
Æqui Polio.
Æquipondium
Æquum
Æra
Ærarium
Aërial Perspective
Aëro-Dynamics, Statics, etc.
Aërology
Aërometry
Ærugo
Æsculapius, Temples to
Æsculus (Hippocastaneæ) Bot.

The remainder of this list of terms is in preparation.

Wyatt Papworth.

ABATTOIR.

Plates 74, 75, and 76.

Abattoir, the French name for all slaughter-houses, is now adopted into the English language, but is more generally applied to public slaughter-houses only, and it is in this restricted sense that the word will be employed in the following observations.

It appears that some concentration of the slaughter-houses, analogous to that which prevails at the present day in many large towns of the continent, existed in ancient Rome under the later republic, and the first emperors.

From the frequent allusions of the satirists to the number of modes in which swine's flesh was prepared, it would seem also that the ancient Romans consumed more pigs than they did cattle. It is probable that the difficulty of rearing cattle in the burning plains of Italy, especially before irrigation was applied to the extent to which it actually exists in Lombardy and Piedmont, may account for the preference of agriculturists to rear the hardier animal, the pig.

From passages in Plautus, Terentius, Plinius, Florus, and Tacitus, it may be inferred that the cattle consumed in Rome were first exposed in a Forum *Boarium*, or *Suarium*, according to their nature; they were then led to the *laniena*, where they were killed and prepared by *lanii*, *laniones*, or *carnifices*; and finally the meat thus prepared was exposed to sale in the *macella*, or the market places for provisions. The Boarii and Suarii (the cattle and pig butchers), originally formed separate *collegia*, or corporations, under the supervision of the præfecti urbis. They elected syndics, who decided any disputes between members of the respective corporations, and who were empowered to prescribe the regulations of the trade. Subsequently the two corporations were united.

The Forum Boarium was situated near the Circus Maximus, between the Montes Palatinus and Aventinus, and at the extremity of the Velabrum. It was in the immediate vicinity of the Porta Carmentalis, and near the outfall of the Cloaca Maxima. According to Tacitus, the name "Boarium" was given because a bronze figure of a bull was placed in it; and Plinius states that this figure was brought from Ægina. Festus, however, expressly says that the name was given "quod ibi venderentur boves". The modern church of S. Giorgio in Velabro is placed near the ancient Forum Boarium: see Plautus, in *Curculione*; Terentius, *Eunuchus*; Tacitus, *Annales*; Plinius, etc.; or more concisely, Grævius, *Thes. Ant. et Hist. Italiæ*, etc., fol., Leyden, 1725; and Muratori.

No details of the interior organisation of the *lania* have been handed down to us; but from the fact of the various trades connected with the sale of the cattle, and with the preparation and sale of the meat, being concentrated near the mouth of the Cloaca Maxima, we may perhaps assume that some attention was paid to their drainage. The locality in question was also removed from the centre of the town, and placed so as to allow the cattle to be conducted to the markets, without traversing the streets; the information upon the subject of this branch of the municipal regulations of the capital of the ancient world is, however, very limited.

In the museum of the Vatican there exists, or existed in the time of d'Alembert, a slab containing a decree by Turcus Apronianus, præfect of the town, regulating the sale of meat; from which it would appear that in the early periods of Roman history, the bargains between the buyer and seller were made in a manner similar to the game of *morra*, practised in Italy amongst the lower classes at the present day. The decree in question prescribed that the sale should thenceforward be effected according to weight. The decree is quoted at length by D'Alembert and Diderot, *Encyclopédie*, in the section of "Antiquité", under the head "Boucherie". The same authority also describes a medal of Nero, to commemorate the erection of the Macellum Magnum, built by his orders for the sale of meat. It is represented on the reverse of the medal, as a circular building surrounded by columns, and raised on four steps. It is said that this Macellum was a very magnificent building, even when compared with the baths of imperial Rome; but the writer of the *Encyclopédie* does not quote his authorities for this assertion.

During the middle ages several attempts were made to remove slaughter-houses from the inhabited parts of the towns, and in the time of Charles IX of France, a building was erected at the Marché Neuf of Paris, upon the banks of the Seine, for the express purpose. It was built under the directions and upon the designs of Philibert de l'Orme, and appears to have been nothing more than a large hall where the beasts were slaughtered in common. In many other towns, in our own country as well as abroad, similar public abattoirs were constructed; and it is therefore more than probable that several of them may have a date antecedent to that of the celebrated abattoirs of modern Paris. But as these were the first to be established upon general principles, and for the use of a large metropolis, they may be considered to offer the greatest historical interest; whilst at the same time the remarkably successful manner in which the various problems connected with their construction and organisation have been solved, renders their examination in detail far more interesting.

Until the year 1810, Paris presented similar spectacles of suffering on the part of the animals, and brutality on the part of the drivers, to those which revolt the inhabitants of London; and like our own slaughter-houses, those of Paris might have been included in d'Alembert's definition, for he states, "les boucheries dans la pluspart des villes modernes sont des rues infectes, où les gens occupés du même métier ont leurs étaux"; in fact, he adds, "telles sont celles de Paris, excepté celle du Marché Neuf". The butchers used to slaughter the cattle at their places of business; and the various trades connected with the disposal of the offal, such as the tripe boilers, fat melters, etc., were equally carried on in the heart of the town. The circulation in the streets was necessarily impeded there, as it is here at the present day, by the passage of the animals, wearied, faint, and exhausted, sometimes maddened by pain and thirst from their exposure in the markets, and their journey in the paved streets. About that period, however, Napoleon appointed a commission to examine the whole question of the supply of butchers' meat to Paris; and on the 9th February 1810, a special committee was named for the purpose of preparing the designs for the five abattoirs it had been determined to erect.

This executive commission was composed of the five architects to whom the works were entrusted, namely, MM. Petit-Radel,

Leloir, Gisors, Happe, and Poidevin; and at its head was the vice-president of the "Council of Civil Buildings"; M. Combault, a retired master butcher, was appointed secretary.

The first plans proposed for the abattoirs of Paris were designed, according to Bruyère, more with a view to their being worked by a company, than according to the system actually adopted, in which the butchers are at liberty to kill their beasts at their own convenience, and perfectly independent of one another. The works of the abattoirs at Montmartre were even commenced upon these original plans; but when Bruyère was appointed vice-president of the Council of Civil Buildings, he deemed it necessary to introduce several modifications, which have led to the construction of the abattoirs as we see them at the present day.

The cattle for the supply of Paris are purchased at the various markets situated outside the town, at Poissy, Sceaux, la Chapelle, St. Denis, Gentilly, Montmorency, Arpagon, and St. Germain. The markets of Poissy and Sceaux are exclusively for the sale of bullocks, cows, calves, and sheep; that of la Chapelle, for cows and pigs; the others are for the sale of pigs only. Poissy is situated about seventeen miles to the north-west of Paris; and Sceaux, about seven miles and a half to the south; or, in French dimensions, respectively twenty-seven and eleven kilomètres.

From the two principal market places the cattle are driven, according to the requirements of the purchasers, to a series of lairs, six in number, one for each of the five Paris abattoirs, and one for the suburban districts. They are thence driven to Paris, under the care of drovers named by, and under the direct control of, the prefect of police, to whose instructions as to the manner of driving, and the route to be followed, the drovers are bound to conform. The cattle are collected into droves of not more than forty each; the bulls are fastened to the tail of a cart; the calves are laid one upon the top of the other, with their legs tied, either upon carts, or moveable trucks adapted to railway waggons; and the sheep are driven in flocks of not more than one hundred and fifty each. The price for thus conducting the beasts to the abattoirs is also fixed by the prefect of police, and the drovers are responsible for any accident which may happen to them whilst under their care.

The cattle purchased at Poissy are obliged to enter the limits of the octroi (or the region within which the municipality is entitled to levy tolls) by the barrière du Roule; those purchased at Sceaux enter by the barrière d'Enfer. From thence they are driven to the respective abattoirs along the outer boulevards which surround Paris, immediately within the line of the octroi walls. Beasts purchased in any of the other markets are subjected to similar arrangements, and are only allowed to be driven upon the outer boulevards. Under no circumstances whatever are they allowed to traverse the more densely populated parts of the town, or to interfere with the traffic of the streets. In provincial towns also the same rules are enforced; the beasts are led *round*, never *through*, them, at least if they be of any importance.

The five abattoirs of Paris are placed in the vicinity of the exterior boulevards, and more with reference to the geographical position of the town than to the wants, or the density of the population near to them. They are, beginning from the west, and passing thence through the north, and east, to the south:—

1. (Plate I, Fig. 2.) The abattoir of Roule, situated in the rue Miroménil, near the barrière de Monceaux.

2. (Fig. 4.) The abattoir of Montmartre, near the barrière of the same name.

3. (Fig. 7.) The abattoir of Ménil Montant, near the Marais. These three are on the north side of the Seine.

4. (Fig. 3.) The abattoir of Villejuif, near the boulevard d'Italie.

5. (Fig. 1.) The abattoir of Grenelle, near the Invalides. These two are on the south side of the Seine.

It will be seen from the plans, Plate I, that the principles of the distribution are the same in all these constructions, and that they consist of a series of detached buildings for the required purposes, separated by wide open courts. They are composed, 1. Of residences for the gatekeepers and guardians, marked A A, Fig. 1, with the necessary offices and machinery to register and weigh the cattle. 2. Of large spaces K K, enclosed by iron railings, into which the beasts are driven from the markets, and from which, after being selected, they are led to the stalls appropriated to the respective butchers. This sort of classification of the cattle affords also the means of a preliminary examination as to their sanitary condition by the government inspector named for that purpose. 3. Of the lairs, or "bouveries" B B, which surround the killing places, and are always of equal area to the latter. 4. Of the killing places themselves, or "échaudoirs" C C, arranged in a double row on either side of a court D D. 5. Of the tallow-melting rooms, or "fondoirs" F; and the tripe cauldrons, or "triperies" E E. 6. Of the various dependances, such as the engine for raising water G; the coach-houses and stables for the butchers H H; privies and cesspools I I; the positions of these dependances vary, in many cases, according to the natural configuration of the ground. The above references apply to the abattoir of Grenelle, Plate I, Fig. 1; but the arrangement of the various departments is sufficiently uniform throughout all the Paris abattoirs to dispense with a description of each. They are given in block, from which the disposition, etc., of the buildings will be readily understood.

The lairs are of two stories; the under one being reserved for the cattle, and the upper story being used as a magazine for fodder, or other provisions. The clear internal dimensions are usually forty-five mètres in length, by nine mètres in width (one hundred and forty-seven feet eight inches by twenty-nine feet seven inches, with a height of fourteen feet ten inches to the underside of the ceiling). The cattle are attached to rings let into the wall, and are allowed a frontage of one mètre each, or about three feet four inches; the sheep are enclosed in wooden pens, tolerably high, and provided with mangers. A regular inclination is given to the floor, from both sides, towards a channel which conducts the liquid manure to the cesspools. In some of the abattoirs water troughs are placed for both the sheep and the cattle; but generally speaking they are led to large open watering places, or "abreuvoirs", in the courtyards. Access to the fodder magazines is obtained by means of staircases, generally placed on the same side as the sheep pens.

Between the lairs and the slaughter-houses are open passages, ten mètres, or thirty-two feet ten inches, wide. The slaughter-houses, arranged in a double row, are also separated from the opposite group by similar open passages, thirty-two feet ten inches wide, and their clear dimensions are the same as those previously stated for the lairs; that is to say,—a block of eight slaughter-houses, and the staircase to the lofts, measures one hundred and forty-seven feet eight inches by twenty-nine feet seven inches, in the clear of the walls enclosing the two last slaughter-houses. The internal dimensions of the separate slaughtering places are twenty-nine feet seven inches by fifteen feet eight inches, and the well hole to the loft with the passage leading to it is of the same dimension.

In the Paris abattoirs this arrangement, by which a staircase is reserved to give access to a loft occupying the whole range of the building over the slaughter-houses, prevails without exception. The second story was designed for the purpose of receiving the fat from the carcases slaughtered below, but it has been found that there was so great an advantage in extracting the stearine from the fat at the earliest possible period after the death of the animal, that this loft is very seldom used for any other purpose than as a magazine for the hides. In the provincial abattoirs lately constructed, the second story over the slaughter-houses has been omitted, thereby giving rise to a notable economy in the cost of the construction. Another

recent modification in the details of this description of building, is that the passages between the groups of slaughter-houses, in which many of the operations for preparing the carcases are carried on, are covered over, instead of being left open as they are at Paris. The abattoirs of Caen, Nantes, and Versailles, may be cited as illustrating the system now generally adopted in France with respect to these details.

The separate slaughter-houses are divided from one another by walls of very hard stone, the " liais" of French architects, about eight inches thick. (The term " liais" must not be confounded with the word used to designate the secondary formation known to our geologists as the lias. Both lithologically and geologically, the two formations are essentially different. It is important, therefore, in reading any technical descriptions of the buildings of Paris, to remember that the term " liais", as applied to them, means a compact carbonate of lime, nearly pure, being the hardest bed of the subdivision known as the " calcaire grossier", and of the tertiary formations; whilst in the Départements the same term is applied to the argillo-calcareous secondary deposit, properly called the lias.) All angles, in which blood, or filth, is likely to collect, are carefully rounded off. The bottom is paved, and laid with a fall towards a species of cesspool destined to receive the blood. Great care is requisite in bedding the paving, not only of the slaughter-houses, but also of the intermediate courts, to secure them against the attacks of rats. At Caen it was found that the only means by which these vermin could be prevented from undermining the paving was by bedding the latter upon a layer of concrete three feet thick.

Two longitudinal beams are let into the wall at one end, and suspended from a cross beam at the other, as shewn in the details in Plate 2, for the purpose of receiving a series of rollers, from which the carcases are suspended during some of the operations; the height to the under side of these beams is about eight feet four inches. A series of wrought-iron hooks are also let into the side walls, as shewn, to receive the carcases of sheep, or other small animals. In one corner, a single purchase crab is placed, by means of which, and the pulleys attached to the roof, the carcases are hoisted upon the above-mentioned beams. In one of the opposite and higher corners a stand-pipe, about an inch and a quarter diameter, with a common stop-cock, always under pressure, affords the means of effectually cleaning the pavement whenever it may be required.

Wire gratings are let into the partition walls, and over the doors, so as to maintain a constant circulation of air throughout the building; and it is to be observed that in the abattoirs lately erected a very serious defect exists, insomuch as from the suppression of the additional story, without having introduced a ceiling beneath the roof, atmospheric influences are able to modify the temperature of the slaughter-houses with great rapidity. It is impossible to call the attention of architects charged with constructions of this nature too repeatedly, or too forcibly, to the necessity for securing a constant and uniform temperature, or the most efficient means of ventilation, both in the interest of the workmen employed, and that of the preservation of the meat. In the Paris abattoirs, these objects are certainly attained in the most effectual manner; and their comparative sweetness, freedom from smell and flies in summer, and constantly uniform temperature, are worthy of particular observation.

Rings are let into the floor for the purpose of tieing down the cattle to be killed. All other tools or implements are furnished by the butchers using the slaughter-houses.

Beyond the lairs and slaughtering-places are placed in the Paris, and in the generality of the French abattoirs, the establishments for melting the fat, and preparing the tripes. The former operation is beyond doubt a nuisance, and under many circumstances the latter is not less objectionable. When the two are combined, they give rise to a sickly, fetid smell, which at the same time that it is very repulsive, cannot fail to be prejudicial to the public health. These operations, in fact, should never be allowed to be carried on in the interior of a large town.

In the abattoir of Ménil Montant, the most convenient and the most complete of all those erected in Paris, the tallow melting places, or " fondoirs", are placed in two buildings opposite to the entrance gates, at the end of the large courtyard. In each of these buildings are four fondoirs, separated by wide passages, and with cellars in which the melted tallow may be stored. The outside dimensions of the walls enclosing each " fondoir" are eleven and a half mètres, by eight mètres (thirty-eight feet three, by twenty-six feet three inches); and in each of them is placed a copper of a capacity to hold from one and a half to two tons. The melting is generally performed by means of an open fire; and although of late years it has been attempted to introduce the use of steam for this purpose, little progress has been made in its application. The usual practice appears to be to allow one fondoir to eight slaughtering places.

The " triperies" at Ménil Montant occupy two ranges of buildings opposite to, and of precisely the same dimension as, the lairs, placed transversally to the slaughter-houses; but it would appear that one " triperie", about twenty-nine feet seven inches long, by about thirteen feet two inches wide in the clear, is all that is required for four slaughtering places. A copper is placed in each triperie, and a copious supply of water is laid on.

Stables and cart-houses are provided for the use of the butchers using the abattoirs, in the proportion of one stable and cart-house to every six slaughter-houses.

When the abattoirs were originally constructed, the water supply of Paris was far from being in so advanced a condition as it is at present, and in most of those establishments considerable expense was incurred in sinking wells, erecting engines and pumps, and forming reservoirs. Actually, the water is supplied by the town distribution, from the canal de l'Ourcq, to such of the abattoirs as are near the directions of its mains. It is calculated that about forty-five gallons of water are required for each head of cattle slaughtered. The town of Paris have contracted for an annual supply of about twenty-two million gallons to the five abattoirs; but it is considered that this quantity is not half of that really required.

Upon a review of the system thus sketched, it appears that the necessary conditions for its efficient working have been, upon the whole, successfully resolved in the Paris abattoirs. The cattle are lodged in airy, convenient quarters, where they are allowed to repose from the fatigues of the road before being killed, and in which the government inspectors can easily examine them. In the slaughter-houses the killing and conversion of the carcases takes place with all the advantages of good air, room, cleanliness, and uniform temperature necessary to insure the healthy state of the meat. The concentration of the fondoirs and the triperies in the same establishments is objectionable; and it would be advisable in any new work of this description, to adopt the modifications of the slaughter-houses and intermediate courts above described.

From the returns quoted by Bizet, it appears that the abattoirs are resorted to in variable proportions, as follows, the terms of comparison being based upon the total consumption for the whole town of each description of animal.

Name.	Cattle.	Cows.	Calves.	Sheep.
Montmartre	42 per cent.	34 per cent.	43 per cent.	50 per cent.
Ménil Montant	29 ,,	44 ,,	23 ,,	27 ,,
Grenelle	16 ,,	13 ,,	17 ,,	12 ,,
Roule	9 ,,	4 ,,	12 ,,	8 ,,
Villejuif	4 ,,	5 ,,	5 ,,	3 ,,

The number of separate slaughter-houses being respectively at Montmartre and Ménil Montant sixty-four each, at Grenelle forty-eight, at Roule and Villejuif thirty-two each; so that it would appear that the three last-named abattoirs are considerably in excess of the requirements of their immediate vicinity.

This opinion is further confirmed by the fact that in 1846, of the total number of cattle killed in Paris, which was 674,048 animals of all sorts, such as bullocks, cows, sheep, and calves, 320,024 were taken to the abattoir of Montmartre; 192,856 to that of Ménil Montant; 77,678 to that of Grenelle; 54,138 to that of Roule; and 28,852 to that of Villejuif. But it is necessary to observe, that the determination of the proportionate number of slaughter-houses to any particular population, is affected by the two-fold condition of the population in the first instance, and of their average meat consumption in the second. Thus, it is well known that the poorer classes eat comparatively little meat, and that of the coarser description; whilst the greatest average meat consumption takes place amongst the wealthier middle classes. These habits appear to have had fully as much influence as the mere population itself has produced upon the results observed, viz., that the greater number of cattle are sent to the abattoirs at Montmartre rather than to those of Villejuif and Roule, and that the comparatively greater number of calves and sheep are killed at Grenelle.

Each slaughter-house at Montmartre sufficed for killing and preparing about 5,000 animals per annum; at Ménil Montant for 3,130; at Grenelle for 1,618; at Roule for 1,691; and at Villejuif for 900 only. On occasions of great demand it has been observed that it was possible to prepare in one slaughter-house, without inconvenience to the work-people, as many as ten cattle and fifty-five smaller beasts; so that even the abattoir of Montmartre would suffice for a consumption three times as great as is now supplied by it.

The architectural character of the abattoirs of Paris may be judged of by the illustrations, copied from Bruyère, on Plate III. They are bold, massive, and if fitness be the criterion of beauty, they may be considered as possessing that quality. The effect is produced entirely by the broad outlines of the buildings, and no useless detail, no affectation of prettiness, is allowed to interfere with the severity of the composition. Great attention was paid to the choice of materials, and these have been so combined that their respective colours add to the general effect; thus, the piers, strings, and arches are executed of the "roche", a fine-grained, whitish limestone; the spandrils, and many of the large plain spaces of the walls, are filled in with the bistre coloured *meulière*, a species of quartzose concretion, stained by the peroxide of iron, the innumerable cavities of which again increase its picturesque effect,—and the rich brown tint of the tiles, combining with the other colours, gives a generally warm and pleasing tone to the whole mass. The deep shadows of the projecting roofs, and the play of light and shade upon the channels of the pantiles, also contribute to this general effect in a remarkable degree. There is, in fact, about these buildings the singular character of monumental grandeur, if the expression may be allowed, which distinguishes all the works executed by the orders of Napoleon; at the same time that they may be styled perfectly consistent with the objects for which they were erected. In some of the provincial abattoirs recently constructed this simplicity of character has been departed from a little, as in the introduction of the pilasters upon the side buildings at the abattoir of Versailles (Fig. 5, Plate II), and the bullocks' heads upon the keystones of the arches; but it is certainly questionable whether these ornaments are not misplaced, and inconsistent with the purposes of the building. Slaughtering cattle is a necessary operation; but it may perhaps be considered a proof of bad taste to ornament the place in which it is carried on, because it would induce the belief that a cultivated mind could find pleasure in dwelling upon its details.

The cost of the abattoirs of Paris was considerably in excess of that of the more recently-constructed buildings of the same character; nor should this be matter of surprise. They were the first public abattoirs erected upon a large scale; and necessarily, in endeavouring to solve the difficulties of the case many experiments were made, and many modifications introduced. The political and financial crisis which France passed through in 1814 and 1815, also increased the difficulties and the cost of these works, as well as delayed their completion. Nevertheless, the total expense was such that the town is able to derive from them an interest of more than five per cent. upon the capital, after paying all the working expenses,—"a description of merit", as M. Horace Say observes, "by no means to be despised".

Bizet enumerates carefully the costs of the different abattoirs, and gives a minute account of the length of water-pipes, the number of stop-cocks and of the lamps. The latter details afford but little information to an English architect, because both the water supply, and the mode of lighting, are different in our country from what they are abroad. The most valuable results to be obtained from Bizet's work have therefore been grouped in the following table, in which the dimensions and prices given by him are translated into English. The first column contains the surface of the land occupied by the whole of the respective establishments, with their court-yards, passages, and appendages; the second contains the surface of the roofing; the third contains the cost of the land; and the fourth, that of the buildings.

Name.	Yards supl.	Yards supl.	£. Sterling.	£.
Montmartre	44,539	13,000½	1,581½	189,001
Ménil Montant	59,794	14,598	5,308	163,019
Villejuif	32,531	7,475	2,176½	96,350
Grenelle	38,475	9,974	4,862	123,005
Roule	28,297	7,475	8,563½	100,036
Totals	203,636	52,522½	22,491½	671,411

From this statement it would appear that the cost of the Paris abattoirs was at the rate of £3 : 8 : 2 per yard superficial of the whole surface of the ground occupied; and at the rate of about £13 : 4 : 5½ per yard superficial of the covered portions. In consequence, however, of the experience gained by the construction of these buildings at Paris, the cost of similar buildings in the provinces of France has been kept much below the above averages. Thus, at Nantes, the price per yard superficial of the covered portion did not exceed £6 : 8 : 9. At Hâvre, the price per yard superficial of the whole of the ground occupied was about £1 : 6 : 9; and at Caen, it was about £2 : 0 : 10 per yard superficial.

The abattoirs of Caen, Nantes (Fig. 5, Plate I), and Versailles, to which allusion has been made, were constructed for, and at the expense of, the municipalities of the respective towns. At Hâvre (Fig. 6, Plate I) the abattoirs were built upon lease; the town finding the land and paying the land-tax, the lessee paying all other taxes, building and maintaining the abattoirs to the satisfaction of the town council, upon a lease of eighteen and a half years' duration. The lessee is also, it may be observed, contented with his bargain in this case, hard as the conditions may at first appear.

The working expenses of the Paris abattoirs are about twelve per cent. upon the gross receipts; including all salaries, water-rents, lighting, repairs, etc.

A species of monopoly exists in favour of the public slaughter-houses, in consequence of the legislation upon the subject, which provides that when a municipal abattoir is opened after proper inquiries, with the consent of the Minister of the Interior, no private slaughter-house is allowed to exist within the limits of the said municipality. But as the limits of the municipal districts of the provincial cities are not extensive, at least in such towns as Caen and Hâvre, the legal monopoly would not ensure sufficient returns upon the outlay, did not the butchers, even of the vicinity, who are equally free from the tolls payable to the corporations, find that they have a direct interest in using these public establishments. It would indeed seem self-evident, and the experience of the French butchers has proved it to be really the case, that the meat, killed and prepared under circum

stances such as to allow of the observance of all hygienic precautions, must be of a better quality and more likely to be preserved, than that killed and prepared in unwholesome, dark, close, and filthy holes, such as the private slaughter-houses almost invariably are.

It may be as well to state, that there is no law by which towns are compelled to erect abattoirs; the general feeling, and we may add, the common sense of the respective municipal councils, has been found sufficient to ensure their construction in nearly all the large towns of France.

The revenue is based, at Paris, upon a toll of two centimes per kilogramme of the meat taken from the establishment, or about 0.0907 of a penny per pound avoirdupois. The rate per head may then be taken at about *5s. 9d.* per bullock; *5s. 2d.* per cow; 1*s.* $0\frac{1}{2}$*d.* per calf; and *4d.* per sheep. The rent for the "fondoirs" is 10*d.* per 100 kilogrammes, or 2 cwt., of tallow produced, the melters finding their own fuel. The payment for the tripe-boiling places is *3d.* for every bullock's tripe, and $0\frac{1}{2}$*d.* per tripe of a sheep. In all cases the town furnish everything which may be considered to constitute what we should technically designate as *plant;* the *tools* and other working utensils, are furnished by the parties using the abattoirs.

Before examining the different systems adopted in other towns, it may be advisable to mention, that although the town of Paris has not yet completed any abattoirs for the slaughtering of pigs, the preparation of the carcases of those animals is only allowed to take place in private establishments under the immediate superintendence of the municipal authorities. The private slaughter-houses for pigs are situated Rue de Carême Prenant, Rue St. Jean Baptiste (out of the Rue Pepinière), and Rue des Vieilles Tuileries. There is a large pig abattoir at Nanterre, not far from St. Germain, in which latter town one of the most important pig fairs is held, on the Mondays; and in it nearly half the pigs consumed for the supply of Paris are prepared. The abattoir of Versailles, Fig. 2, presents considerable accommodation for this purpose; and indeed, the bulk of the pork brought into the capital appears to be conveyed thither as dead meat. The town of Paris commenced some years since a pig abattoir in la Rue du Chateau Landon.

The payment for the use of these private slaughter-houses is based upon the same principles as for the use of the public abattoirs, or at the rate of 0.0907 of a penny per pound avoirdupois, if the beasts be prepared by the butchers, or rather the meat salesmen themselves. The proprietors, however, usually undertake to slaughter, prepare, and deliver the pigs at the rate of 1*s.* 3*d.* per head, to any part of the town.

The dimensions of the "échaudoirs" in the pig abattoirs are different from those destined to larger animals. At Nanterre they are sixteen in number, arranged according to the woodcut below, alternately an échaudoir and a "bruloir"; for the practice in France, and generally upon the Continent, is to burn off the bristles, instead of removing them by scalding as is done in our own country. The separate divisions are made about eighteen feet wide, from centre to centre of the side walls, and about twenty-two feet two inches long, with a clear height of about twelve feet, which is carried to about twenty-four feet over the burning-places, or bruloirs, to allow the escape of the smoke. The slaughtering places are made with a rapid inclination towards a gutter and basin, placed for the purpose of collecting the blood.

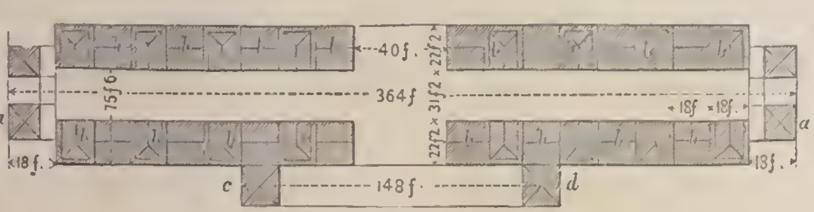


Fig. 1.

a a are the offices and keepers' residences; *b b b* are the slaughtering and burning-places; *c* is a shed, where the carcases are washed after burning; and *d* is a tripery. The total surface of land occupied by this abattoir is 3,305 yards superficial, including the pigsties, etc.; its cost was £3,880; and the average number of pigs killed in it is about 40,000 per annum. The percentage of the working expenses is rather greater than in the Paris cattle abattoirs, on account of the distance from the seat of consumption.

The abattoir of Versailles comprises a series of slaughtering-places for pigs, simultaneously with those for cattle, as is indicated upon the accompanying wood-cut. The offices and residences are marked *a a;* the lairs *b;* the cattle abattoirs *c* (see also Figs. 5, 6, and 7, Plate 2); the pigsties *d;* the pig abattoirs *e;* the burning-places *f;* the fondoirs *g;* the reservoirs are over them; and *h* the cesspools and privies.

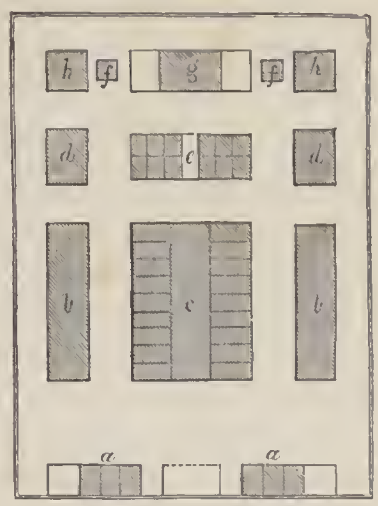


Fig. 2.

OTHER SYSTEMS OF ABATTOIRS.

In some of the towns upon the Continent the details of the abattoirs are arranged upon systems essentially different from that adopted in Paris.

In the town of Rochefort, upon the Charente, the municipality erected a large slaughter-house, in which the whole of the butchers of the town kill and prepare their beasts in common, and under the same roof. Crabs are attached to the walls, by means of which the animals are raised during the operations of their conversion, and a supply of water is laid on. But the working of this establishment is extremely inconvenient; because, as there are no places in which the tools and utensils can be placed in the intervals of their being used, it is necessary to transport them to and fro, on every occasion of their being used, and also to remove the meat as soon as it is prepared. The butchers of Rochefort have usually lairs attached to their own premises, or in the faubourgs of the town; moreover, as the immediate neighbourhood is almost exclusively a grazing country, the cattle are not often kept in the town itself.


Fig. 3.

This building suffices for the wants of a town whose population is between ten and twelve thousand souls.

At La Rochelle, the abattoir consists, as at Rochefort, of a central hall, where the beasts are slaughtered in common; but in addition to it, there are a series of lock-up divisions for the separate butchers. It has no other accessory building, either for receiving the cattle, for the tallow melting, or for preparing tripe.

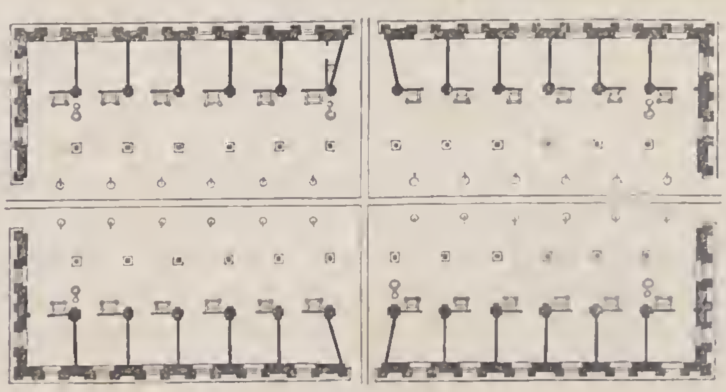


Fig. 4.

This building was erected upon a lease of twenty-five years, and at an expense of about £4,000: the lessee receiving the dues upon the slaughter of the beasts, and undertaking to give up the abattoir, in a substantial state of repair, at the expiration of his lease.

The abattoir of Grenoble differs from the above, in that the

smaller animals, such as the calves and sheep, are slaughtered and prepared in separate divisions. The accessory buildings are rather more complete than at Rochefort, or la Rochelle, inasmuch as they contain courts, stables, and a storehouse for the raw and melted tallow.

At Strasbourg and Marseille are also abattoirs; but although they differ somewhat from those already described, their mode of construction is not such as to call for particular notice. At Lyons, the abattoirs are combined with the meat market, but in a very disagreeable manner. The cattle are slaughtered in the market-place itself under the eyes of the purchasers, who may even be forced to wade in the blood of the victims. Unquestionably, this may be classed amongst what Sir Wm. Chambers would describe as the models to be avoided.

The abattoir of Mantua, situated upon the banks of the canal, is perhaps more worthy of notice for what it might have been made, rather than for what it really is. Bruyère describes it as consisting of a basement, nearly upon the level of the canal, in which are performed the operations requiring the use of large quantities of water, or which produce much refuse; the former is supplied, and the latter removed, by a stream of fresh water constantly running. Above this basement is a ground-floor, upon which the animals are slaughtered, and the meat market is held. Evidently, it would have been much more satisfactory, if in this case, as in that of Lyons, the whole of the operations connected with the killing and conversion of the animals, were removed from the sight of the public. A reference to Plate 3 will, however, shew that the general external effect of the building is satisfactory.

At Vicenza, the operations of slaughtering and preparing butchers' meat are carried on in a portion of the great basilica of Palladio, on the opposite side to the Piazza del Biade.

In modern Rome, the abattoirs are situated upon the road near the city walls, and in the immediate vicinity of the Tiber. The beasts enter by a gate opposite to the Campo Borazio, and are, when required, conducted to a series of lairs constructed against the enclosure walls; a difference in the details of these lairs appears to exist when they are intended to receive the animals destined to remain for several days. Two large slaughter-houses A A B, are provided for the cattle, which are killed in common; covered sheds D D, and uncovered pens or enclosures C C, are formed against the enclosure walls; lodgings and offices

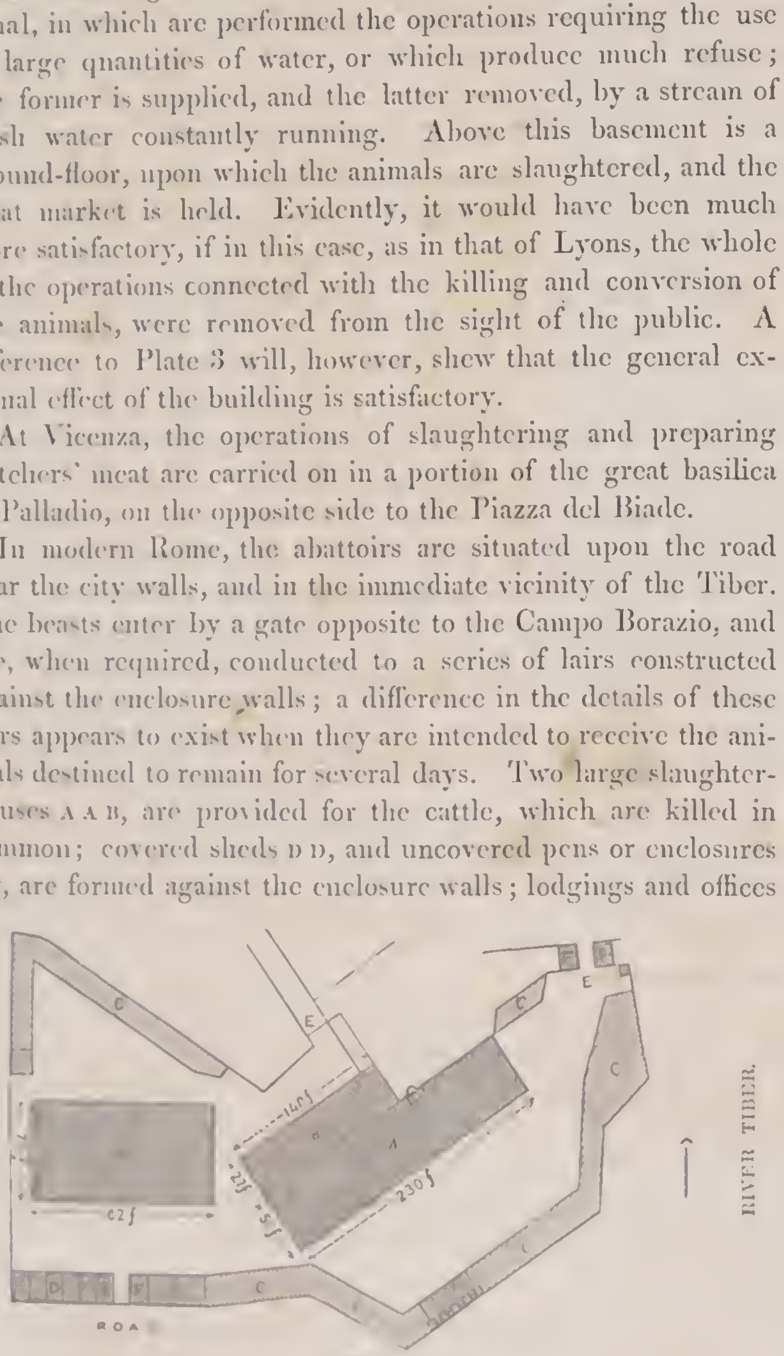


Fig. 5.

are erected for the employés F F; cisterns and wells are also provided, but no tallow-melting places; nor do triperies, or magazines for hides, appear to be included in the arrangements. The absence of these accessories to the majority of the French abattoirs, is unquestionably an improvement; not so, however, the system of slaughtering in common, which gives rise to frequent robberies, and consequent altercations, amongst the lower classes of workmen frequenting these establishments. E E, are separate gates, reserved for the removal of the meat in covered carts, and for the introduction of hay, straw, or other fodder, for the cattle; G G G are open pens for the cattle.

Mr. S. Smirke, who has kindly communicated the notes from which this account of the Roman abattoir is prepared, observed, that "there are no drains for clearing the gutters which carry off the blood, except at the end of each building. The slope is almost imperceptible, and not sufficient; it is therefore necessary to keep the gutters clean with brooms, and they are swept by prisoners. It is, however, very difficult to keep the pavement clean."

Fig. 6. View of long building, A.

"This abattoir was erected by Martinelli, an engineer, at an expense of from 50,000 to 60,000 scudi, or £12,500 nearly. He has a lease of the tolls for twenty years, and at the expiration of that period the whole building will pass into the possession of the municipality." It has now been erected more than twenty years, so that it is probably in the hands of the government.

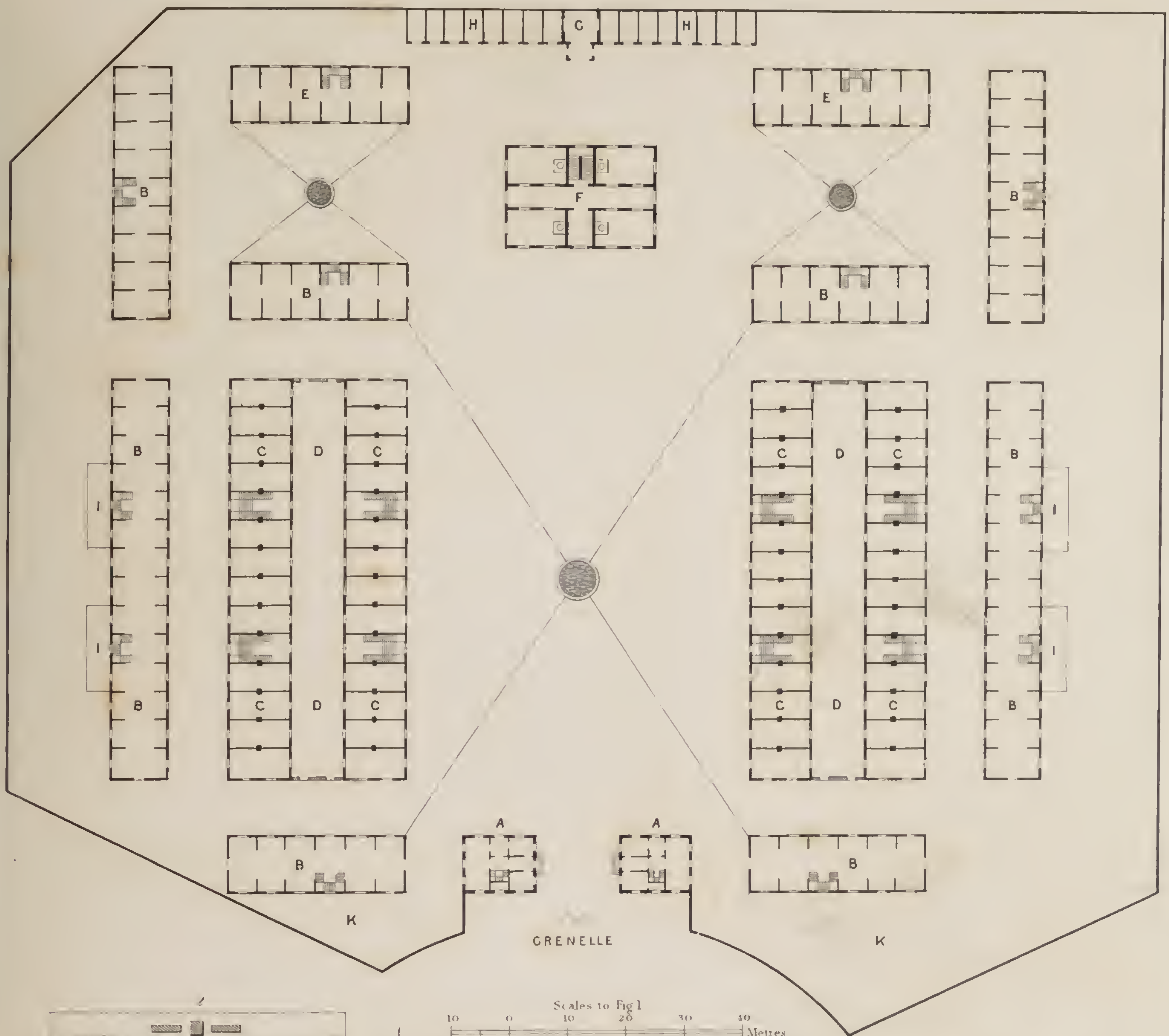
In some of the English country towns, as at Halifax, Liverpool, Glasgow, etc., there are public slaughter-houses, in which the butchers of the town kill and prepare their meat in common. The arrangements of these places are very defective, and they rarely comprehend even the means of securing the necessary degree of cleanliness or of ventilation. For the most part they are constructed in the centre of the towns, and precisely in the quarters most densely populated, from which it is desirable in every point of view, both moral and hygienic, that such establishments should be removed. In the present age of improvement, it is wonderful that more attention has not been paid by our sanitary reformers to this subject; and it must be a source for painful recollection to Englishmen, that in everything connected with the organization of our markets, and the preparation of our animal food, we are far behind many of the civilized nations of western Europe.

G. R. Burnell.

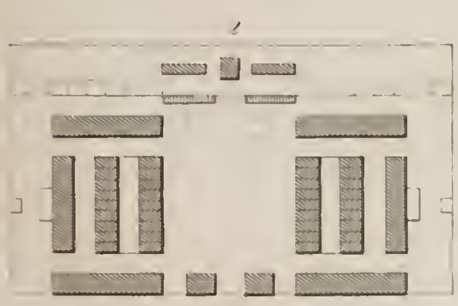
Some further statements upon this subject will be found in Bruyère, *Etudes sur l'Art des Constructions*, folio, Paris, 1823; Bizet, *Du Commerce de la Boucherie et de la Charcuterie de Paris*, folio, Paris, 1840; Gourlier, Biet, Grillon, et Tardieu, *Choix d'Edifices construits ou projetés en France*, folio, Paris, 1826-38; Les Procès-verbaux des Bureaux de la Chambre des Députés sur le sujet de l'approvisionnement de Paris; Normand(Ainé), *Paris Moderne, etc.*, 4to. Paris, 1843-48; Various reports of committees of House of Commons upon Smithfield; Grantham, *Description of the Abattoirs of Paris*, 8vo. London, 1850; and some papers by the author of this article, in the Builder journal, 1850, vol. viii, etc.

ABATTOIR.

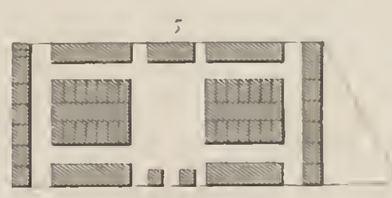
Plate 1.



GRENELLE



ROULE



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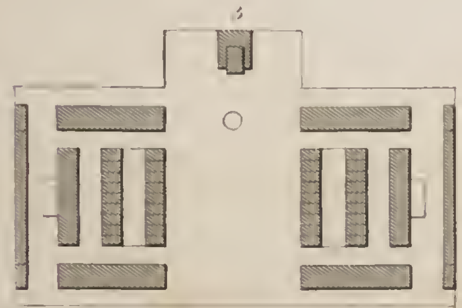

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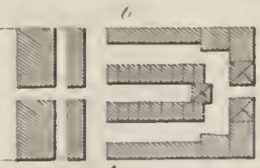

HÂVRE

A [illegible] Employe
B [illegible] Cattle Sheds
C [illegible]
D [illegible] between ditto
E [illegible]
F [illegible]
G [illegible]
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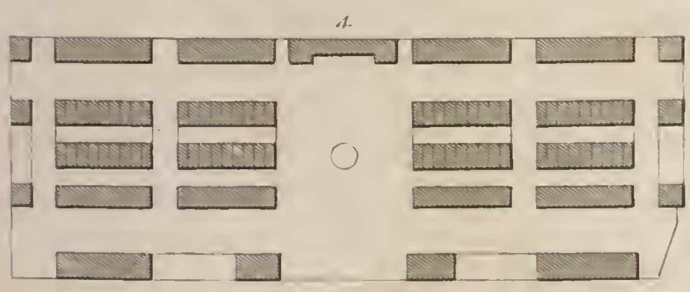
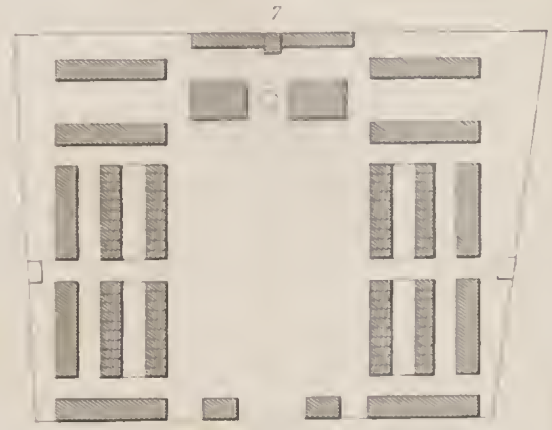
K [illegible] Animals [illegible]



MONTMARTRE



MENIL MONTANT

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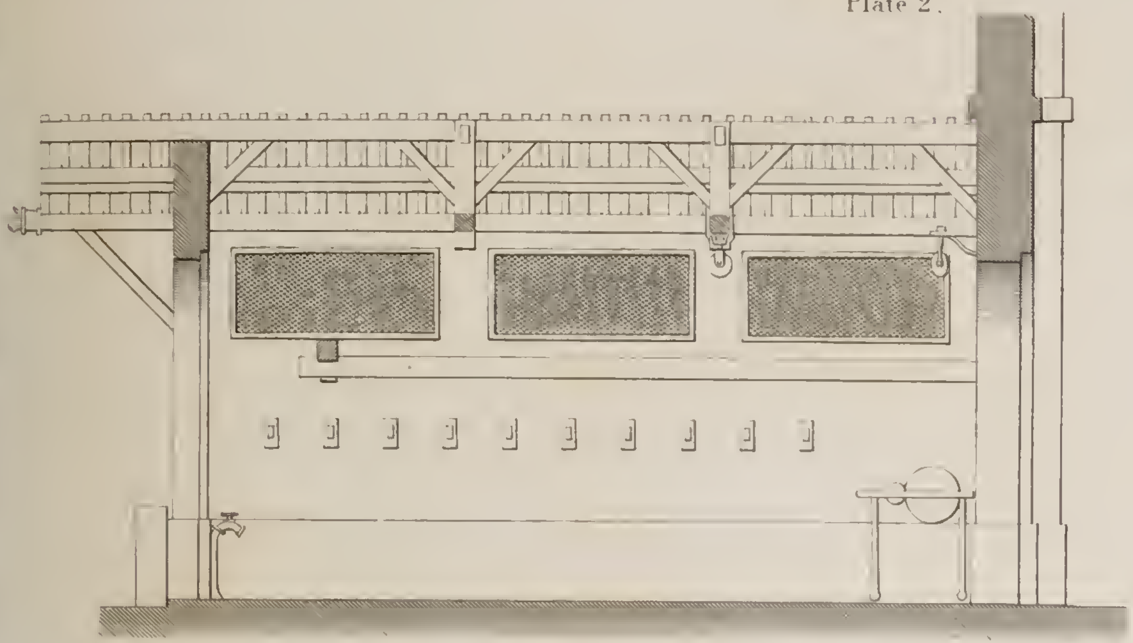
ABATTOIR.

Plate 2.



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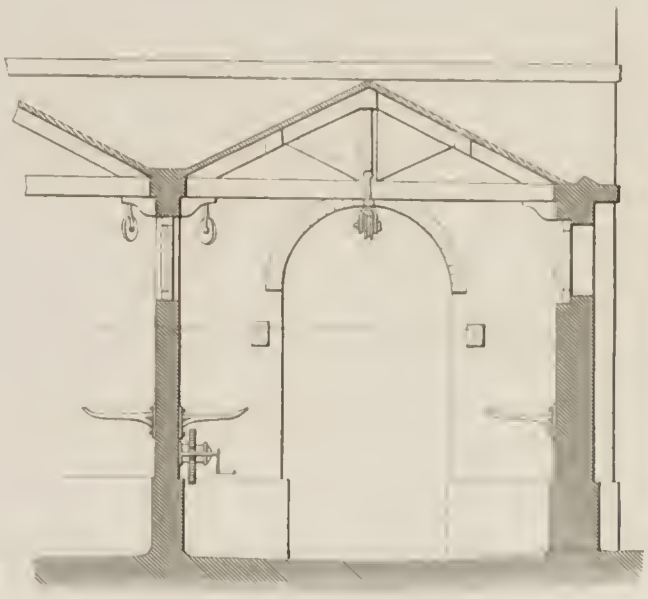

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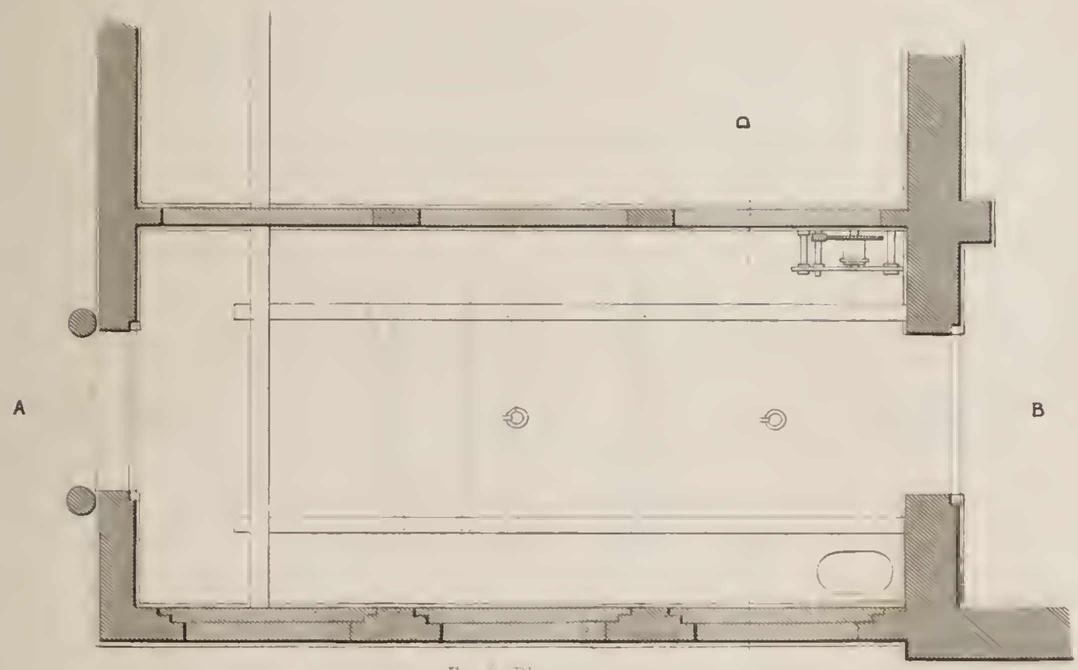
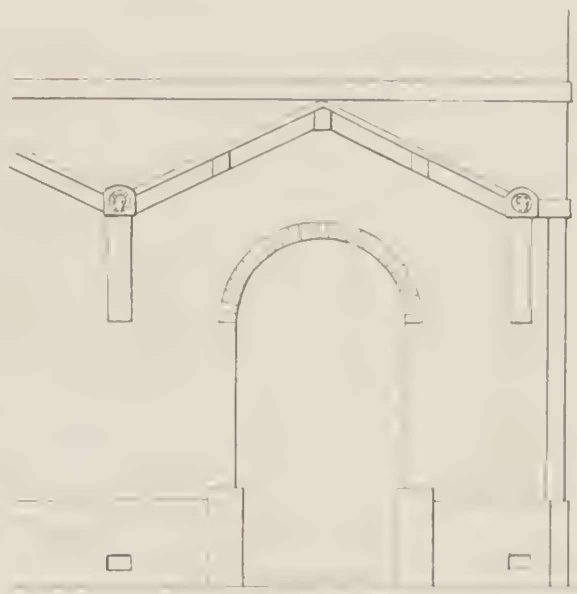
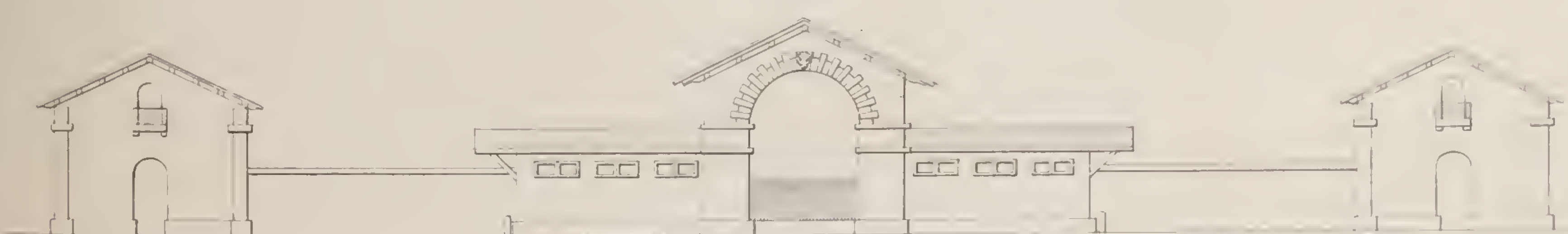


Fig 3 Plan

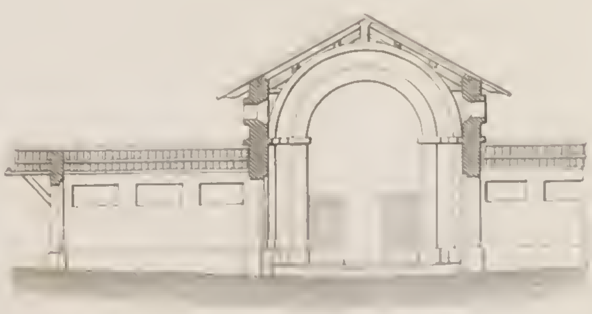


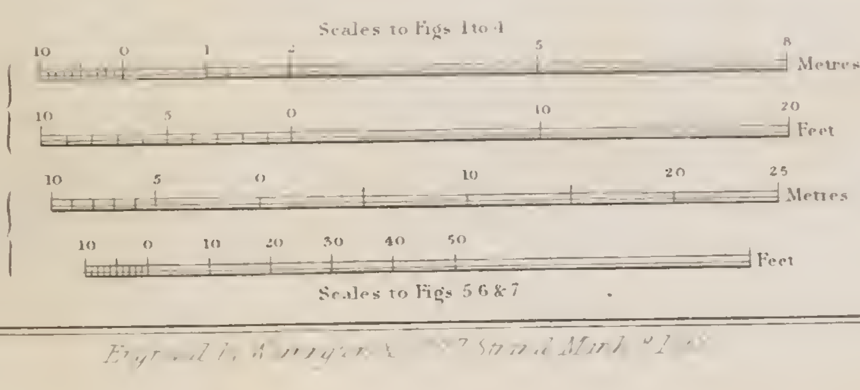
DETAILS OF SLAUGHTER HOUSES



VERSAILLES

Fig 6 Side Elevation of Slaughter House





ABATTOIR.

Plate 3.

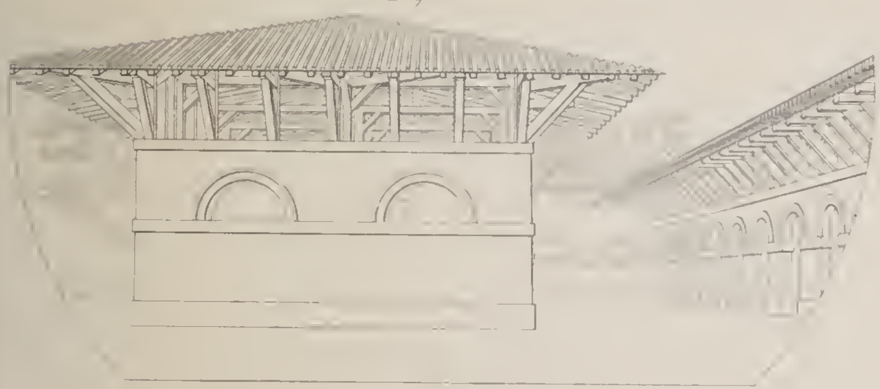
Fig 1

ENGINE HOUSE &c.
ROULE

Fig

LAIRS, OR CATTLE SHEDS

Fig 3



SLAUGHTER HOUSES

Fig 4

MELTING HOUSES
MENIL MONTANT

Fig 5

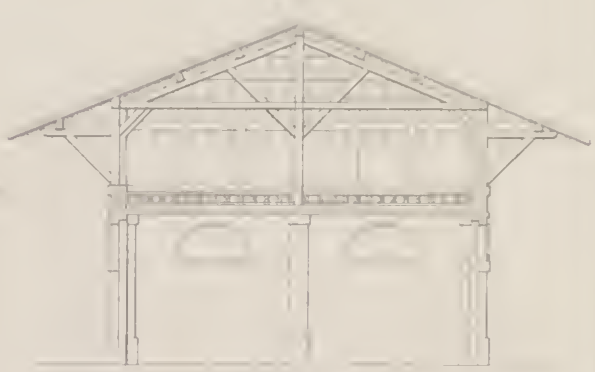
KEEPERS HOUSE &c

Fig 6

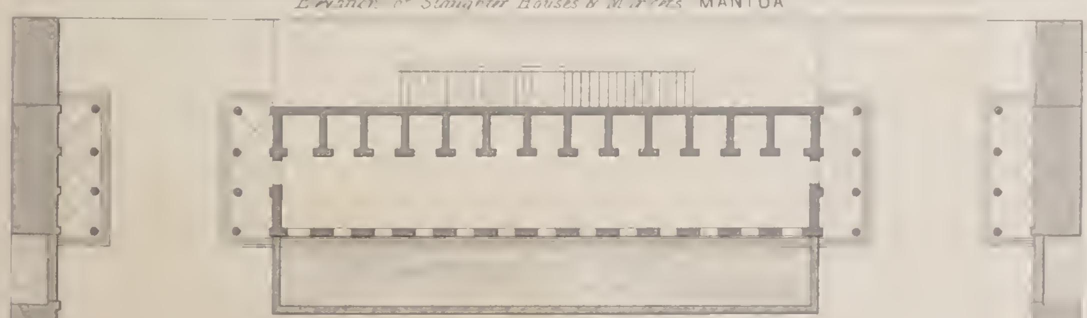
CART SHEDS &c.
GRENELLE

Fig 9

Elevation of Slaughter Houses & Markets MANTUA



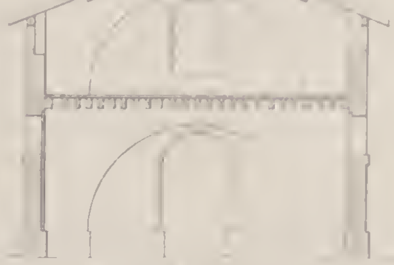
SLAUGHTER HOUSES.



Plan of Ground Floor

Fig

Plan of Basement



LAIRS, OR CATTLE SHEDS.

R. Burn

Engraved by

AQUEDUCT.

Plates 84, 85, and 86.

Aqueduct, or aquæduct, as it was formerly and more correctly written, is composed of two Latin words, *aqua*, in the genitive case *aquæ*, and *ductus*, together signifying a conduit of water. It would thus seem at first sight to be the proper designation of any *means, not manner*, of artificially transporting a continuous stream of water; but the application of the word has been usually confined to structures, which may be described in general terms as conduits, having a regulated fall from the source to the place of delivery, often carried through hills by means of tunnels, and over valleys by bridges, either solid or pierced with arched openings. There is also a secondary limitation, viz., that these constructions should be employed in the supply of water for domestic or ornamental purposes only. Nor can such waterworks be considered in the meaning of the term, as the canal or conduit called the New River in London, those of Central and Southern America, or the subterranean conduits supplying the Fonte Gaja at Siena. These examples are certainly within the strictest limits of the definition of the word aqueduct already given, yet they would not be considered as fulfilling the meaning commonly understood to be conveyed. The term is generally devoted to fabrics, if not entirely on arcades, yet containing in some portion or other at least an important aqueduct-bridge, — fabrics which are interesting alike to the philosopher, artist, and builder, as being the means which gave to Rome and her subject cities, and in many instances still give, a daily supply of one of the necessaries of life; as being works in which harmony of proportion pleases the eye, whilst grandeur necessarily results from the arrangement of the mass of materials; and as being constructions which, especially for canal and railway works, have given useful and necessary lessons of experience in boldness of design and solidity of execution.

The subject has also been considered of high importance to the architect, partly on account of the great works already executed, and partly on account of those, which must be constructed, as soon as an immense population is able to comprehend the necessity, and to provide for the execution, of undertakings which are momentous; because the element which they convey is necessary to the very existence, as well as convenience of life (water), while the efficiency of the supply is absolutely dependent upon the science and economy of its collection (water supply), transmission (conduit, watercourse), and distribution (water service).

The disadvantages of mere empiricism, and the care with which these works were carried out, especially by the Romans, form a strong and sad contrast to the present condition of science and to the supineness of governments pretending to a much higher development of civilization, in more powerful and more highly organized communities. It is true, that an idea, of the imperial Roman love of magnificence conjoined to an ostentatious disregard of expense, has been added to a prejudice against the engineering skill of the ancients; the idea and the prejudice have united to form a reason for throwing aside one of their means for the supply of water; and this reasoning has been fortified by the knowledge that they did not enjoy the power of manufacturing large iron pipes, nor the metallic wealth which is now employed.

The inference seems to have been made too hastily, when it led to the conclusion that the supply through stone or brick channels, with a regulated fall from the head to the place of delivery, would be an unscientific mode at the present time of conveying water from distant sources to large towns, or that it was a mode peculiar to the Romans. The following account will show that all people have more or less adopted it; and the examples of the New York (Croton) and Marseilles (Roquefaveur) aqueducts will prove that the question (a balance of evils) has been very recently decided in favour of the constructed aqueduct over the metal pipe system, by the two people, who claim to be considered, the one as the most economical, and the other as the most scientific, of nations.

A continuous stream of water can only be transmitted artificially in two ways, viz., either by its tendency to find its own level, as in conduits, or by pressure in closed tubes. The various systems of conduits may be classed under six heads:— 1. Channels in the earth; 2. Channels in rocks; 3. Channels of masonry above ground; 4. Pierced trees as pipes; 5. Tubes of stone or terra cotta; 6. Pipes in metal. All these materials have at one time or another appeared in the history of aqueducts, and it only remains to follow that history to see what has been done by our predecessors, and also in the present age. Beginning with the ancient remains in Africa, Syria, Asia Minor, Greece, and Sicily, and then passing through Italy and the German provinces to France, Portugal, and Spain, the account will finish with the corresponding undertakings in the New World.

The great works, now called aqueducts as above explained, do not appear to have a claim to date much before the time of Cæsar: the assertions of late French writers compel, however, a notice that, although they speak in vague terms of an aqueduct at Babylon attributed to Semiramis, the Assyrians have left too few traces of their civilization to assist in this inquiry. The same writers cite an aqueduct of Sesostris; Egypt certainly had made at an early period great progress in hydraulic works; the canal from the Nile to the Red Sea, and the irrigation of the land, are incontrovertible testimonies in its favour; but there are no remains to be placed with certainty to its credit long before the time of the Roman domination. After that period, it is known that the solitudes of Asia and Africa were once covered with flourishing cities, whose populousness, and even whose existence, were dependant upon artificial supplies of a perennial stream of fresh water.

Africa.

Cherchell or Sersell (Iol or Julia Cæsarea) was supplied from the river Hashem, by a large and sumptuous aqueduct, little inferior to that of Carthage in the height and strength of its arches. The aqueduct of Bujeya or Boujeiah (Sarda) is destroyed. Constantina (Cirta) was supplied from Physgeah, a distance of fifteen miles, by an aqueduct, which, although nearly ruined, still shows a series of arcades in three tiers over the river Rummel: the water ran on the second story, and the highest range served as a bridge.

At Carthage, the sewers and two sets of reservoirs of the aqueducts are the structures which have least been impaired or injured; the earthenware pipes through which the water was conveyed require only to be cleansed. Adjoining to the greater

there are two rows of arches, the upper ones being double the number of the lower.

In his examination of the ruins of Ephesus, Mr. Falkener found that in its period of splendour, that city, like all others, had been well provided with water by aqueducts: there remain the traces of two such constructions, one of which came from the north-east, and the other from south-west by west; and a branch. One of these aqueducts is represented in a drawing by him, of the part where it crosses a road near the city, as being of so much beauty in the design and execution of its two tiers of semi-circular arches, as to deserve an illustrative plate to itself.

At Samos Pococke mentions that he did not meet with any information about the Greek channel for water carried through a mountain about 900 feet high, it is supposed by order of Polycrates, to supply the city. The length of the tunnel, according to Herodotus (iii, 60), was about 4,260 feet, and its section a square of about 64 superficial feet: the remainder of the text is too corrupt for edification. But Pococke remarks that the remains of an aqueduct were to be seen along the sides of the hills for a league to the west, having its rise at or near the river Imbrasius; the channel for the water was made on a low wall, except in a very few places, where there are the remains of some arches over a valley on the east side of the city; these arches were at least sixty feet high. The pipes for the aqueduct were made of the celebrated red earthenware. He saw some of them from six to eight inches in diameter; and also in Megale Chora the present capital of the island, others of stone bored through, and about the same size.

The aqueduct at Smyrna is undoubtedly very ancient: the first signs of it, "are about a mile to the east of the valley, in which the Meles runs. The high arches are all destroyed, except some part of the wall on the side of the hills, and some remains of the arch over the river." Again, Pococke says, that "the wall is not built with arches, for there is only one arch over the road that goes to the south, and three or four arches near it, where I discovered the channel of the aqueduct in the wall, which was made of large square stones, one stone being let into another, and a round channel is worked through them; what is very particular, this pipe is laid in the wall a very little above the ground, though the wall is built much higher; and in many places where the wall was broke, I could see no signs of the pipes, not even at top, which I therefore concluded run mostly along the ground, except where the ground is low, and yet in all parts the wall is built high. I saw also many pieces of earthen pipes, and one in the wall three or four feet above the ground, which might be a channel from some other source; but it is not easy to conjecture for what purpose the wall should be built so high, unless there was a channel at the top to convey water to higher places; though as the wall is built so thick at the passage of the road with buttresses on each side, and also some towers to it further to the west, one would be inclined to think that it was designed as some sort of defence against the incursions of enemies. To the south of this there is another aqueduct over the vale just under the castle; it is new built with three rows of arches one over another; towards the bottom of it there are remains of an old rusticated wall, after the manner of the city walls, which shows that an ancienter aqueduct had been there." A mile to the south there are two aqueducts close to a third which crosses the same valley, each having three rows of arches one over another; one of them is new built, the other, which is a very bad fabric, is older.

At Mytilene, in the island of Lesbos, the same traveller saw, about a mile to the south, remains of a very magnificent aqueduct of grey marble rusticated, built across the valley (Pl. i, Fig. 8). The water having run a considerable way on the side of the hills from the south-west, passed these arches, and then went in channels round to the city. The upper arches are turned with brick. This superb monument rivals any other similar construction; and to give some idea of its pristine glory, it has been restored in elevation (Pl. ii, Fig. 10), the line a showing the level of the earth in 1740. The aqueduct is 500 feet long, by about 75 feet in greatest height, with twenty-four arches of 9 feet in span and 3 feet thick; the piers were 9 feet wide by 13 feet thick, in the direction of the axis, measured at the springing. There are two ranges of intermediate arches in the height of the loftiest piers, to give greater stability, and resist any lateral movement. The precaution appears to have been successful, for notwithstanding the numerous earthquakes to which the Archipelago is exposed, the aqueduct of Mytilene appears to have suffered more from the ravages of man than from those of time.

At Ancyra in Galatia are many stone pipes of aqueducts like those at Laodicea, by which the water ran along on the ground, as it does at present from the river, there being towers at certain distances, in which the water ascends and descends in earthen pipes, to make it rise to the higher parts of the town, which is a method much practised in these countries. When the celebrated Atticus Herodes obtained the prefecture of the free cities of Asia, the young magistrate observing that the town of Alexandria Troas was insufficiently supplied, obtained from the munificence of Hadrian three hundred myriads of drachmæ (about £100,000) for the construction of a new aqueduct, which may be traced for several miles; the piers are 5 feet 9 inches in width; 3 feet 2 inches in thickness, and the arches, though destroyed, were 12 feet high. But in the execution of the work, the charge amounted to about seven hundred myriads (say £235,000), and the officers of the revenue began to murmur, until the generous father Julius Atticus silenced their complaints by requesting that he might take upon himself the whole additional expense.

When Pliny was entrusted with the government of Bithynia and Pontus, provinces by no means the richest or most considerable of the empire, he found the cities within his jurisdiction striving with each other in every useful and ornamental work, that might deserve the curiosity of strangers or the gratitude of their citizens. It was the duty of the proconsul to supply their deficiencies, to direct their taste, and sometimes to moderate their emulation. In the tenth book of his Epistles, Pliny mentions the following works, carried on at the expense of the cities: an aqueduct of sixteen miles in length for the use of Sinope, and at Nicomedia, a new forum, an aqueduct, and a canal, left unfinished by a king.—See Cresy, p. 185.

Trapezus, now Trebizond, was indebted to the liberality of Justinian for a church, an aqueduct, and a castle.

The Persians, according to Procopius (libr. 1 and 2), built at Petra in Colchis, under Chosroes Nushirvan, a.d. 531-579, an aqueduct which had three conduits one above another and on the same line, similar in these respects to one of those hereafter to be described as existing at Rome.

Even the Monophysite or Jacobite Christians, having retained the habits of their fathers of the sixth century, embellished, after the supremacy of the Mahometans, the pleasant monastery of Zapharan, about three miles from Mardin in Mesopotamia, with cells, aqueducts, and plantations.

EUROPE.

The *Notitia* mentions that Constantinople, about a century after its foundation, possessed eight aqueducts and reservoirs. Zonaras (L. xiv) mentions the leaden pipes which Justinian or his servants stole from the aqueducts. It is difficult to reconcile this fact with another, that almost every city of the empire obtained the solid advantages of bridges, hospitals, and aqueducts; but the severe liberality of the monarch disdained to indulge his subjects in the popular luxury of baths and theatres.

At present the metropolis is supplied by a conduit from near the village of Papas; by another, commencing near Khalfa, which has a branch, in itself a continuation of two others, and of these one is forked into two lines; by a third, commencing near Kutchuk, and by the two next described.

At Constantinople, says Pococke, they formerly made many

large cisterns as reservoirs of the water of the aqueducts, in case it should fail, and the great cistern under S. Sophia serves for that purpose at this time. The most ancient aqueduct (compare Cresy, p. 185), was built by the emperors Valens and Valentinian; it is seen in three situations; and conveys water ten miles to the city, being brought from places near the village called Belgrade. The three parts of the aqueduct are called the Crooked, the Long, and the High aqueducts. The last is the nearest to Constantinople, and receives the water that comes from the other two, which are different streams. The crooked aqueduct bridge is so called because at one place it makes three turns, one of them an angle of 90°, in crossing the valley, from one hill to the other. "This part is executed in a very fine taste: it is a rustic work, and consists of three tiers of fine arches one over another. The water first runs on a wall, and then over twelve arches for 221 yards; it then turns and crosses the vale on the three tiers of arches, in the lowest there are four arches, in the middle ten, and there are passages made through the piers in the length of the aqueduct, by which one passes to the other side of the valley; in the uppermost tier there are twenty-one arches, the seven or eight first arches on each side are built on the descent of the hill, two or three on the solid wall, and over the middle arches: in the upper story also there are arches through fifteen of the piers, in order to pass the whole length of the aqueduct, as it has been observed there are through the piers of the middle arches; the aqueduct being in that part about 672 feet long, and 107 feet high." The arches of each tier are wider than those below them; the two upper tiers have semicircular, the lowest pointed, arches, which are between 15 feet and 21 feet 6 inches span, on tapering piers from 22 feet to 25 feet wide. "The water is conveyed to it from a rivulet that passes near Belgrade, and is stopped in two different places by a wall built across, so as to make two large lakes, and runs in channels through the wall which is built to keep them up; these seem to be Turkish works. From the last of these their water passes to a deep basin into which some other streams are brought; and from that it runs, partly on the side of the hills, into another basin, and so does the water of the Long aqueduct; and from that basin it goes in one channel to the High aqueduct. The other, called the Long aqueduct, seems to be a modern work, and, I suppose, was built by Soliman the Magnificent, who is said to have repaired the other aqueducts, and if it was, it is a work truly worthy of him; and I saw on it a short Turkish inscription. It was built as a further supply of water to be conveyed by the High aqueduct: it is 2,229 feet long, 85 feet 6 inches high, and the wall is 12 feet thick; it consists of two stories of pointed arches. In the lower story there are forty-seven arches, and fifty in the upper; at the first descent at each end of the hills, the water runs on a long wall. Other streams are brought to this water, by the side of the southern hill, which passes likewise on a small number of arches over the valleys that are in the way. The water of this aqueduct, as observed, communicates with the Crooked aqueduct, and both run to the High aqueduct," or aqueduct of Bourgas (Pl. I, Fig. 9), supposed to be built by Justinian, but surely later in its date; this "is a vast massive rustic building, by which the water is conveyed over a valley. It is above 840 feet long, and 112 feet high; it consists of four large arches, as many over them, and three stories of small ones between them. Fig. 4 shows one of the compartments to an enlarged scale. This aqueduct has a very Gothic appearance, though it is a work of great expense and magnificence, for the walls are 15 feet thick, and the great arches are above 50 feet wide, the piers being strengthened laterally by a range of buttresses triangular in plan. Ascending by the hill to one of the small arches, there is an arched passage from it through the wall, lighted by pointed openings, consisting of forty-four steps, which leads up to the great arches above, where there is a passage through the piers, as in the Crooked aqueduct, and a descent likewise by stairs at the other end. From this aqueduct the water runs along the side of the hills, in channels covered with stone, there being arches built only in two or three places. This water formerly ran on those arches in the third valley, between the third and fourth hill; but the east part of that aqueduct being destroyed, the water is conveyed in channels on the ground to the several parts of the city." That is to say, the conduit in which the High Bridge, or Bridge of Justinian occurs, is about eight miles in length from the walls of Constantinople to that bridge, and continues about a mile further to the junction of its two sources; one of them lies east of Bourgas and is formed by the junction, about a mile above the Crooked bridge, of two sources which rise about a mile east and west of the village of Belgrade, and the other which lays west of Bourgas contains the Long bridge, and begins about two miles west of Belgrade.

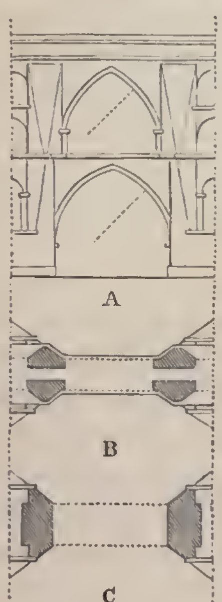


Fig. 4.
A. Elevation; B. Plan of upper range; and C, Plan of lower range of arches.

Andréossi gives drawings of the Crooked aqueduct and of the following one, built about 1730, "to supply Pera, Galata, and the neighbouring villages. The water at first runs across a valley on a bridge which consists of a great number of arches, that are very well built", indeed they are supposed to be part, constructed by the Greek emperors, of an arcade, about 884 feet long, and 168 feet high, in two tiers, the upper range of which has been destroyed by violence; "and from this the conduit runs round the hills, sometimes under ground, and crossing a low ground it rises in a sort of pillar pipe, in order to keep the water to its level. As it passes, part of it is conveyed to the villages on the west side of the canal of the Thracian Bosphorus, and coming near Pera it rises in the same sort of pillars, and finally runs into a reservoir consisting of many little cells, whence it is distributed over Pera." —Pococke.

The Turkish engineers availed themselves of the conduit, and of the remaining arches; but instead of repairing the bridge, they employed the contrivance called *souterazici* by them, but by the Italians *souterazi*; the illustration of which (Pl. II, Figs. 1, 2, and 3), is taken from Genieys. Earthenware pipes convey the water from an upper reservoir on a slope down to a bend (Pl. II, Fig. 3), and up another slope into a basin erected upon a pier in the valley (Pl. II, Fig. 2), from which the same operation is repeated as often as may be necessary; and this single operation forms a souterazici. The piers are spaced at distances of between 600 and 1000 feet, and the difference of level between the supplying pipe in the reservoir on one side, and the discharging pipe on the other, is about four inches. These basins also served as vent-holes for the pipes, and thus may be seen in practice one of the systems enunciated by Vitruvius, which will be noticed preparatory to considering the aqueducts of Rome. A clearer insight into the ramifications of these aqueducts may be obtained from the *Carte des Environs de Constantinople*. Paris, 1829, or from that in Andréossi.

Aqueducts are mentioned by Strabo among the erections which were neglected by the Greeks, and first brought into use by the Romans: this statement requires a little modification, for Herodotus mentions, as above stated, the works at Samos; however, it is clear that before the Roman Conquest, the Greeks had no such grand structures, and no need of them. Springs were sufficiently abundant to supply the wants of the population; at least this seems to be better evidenced by the regulations which provided for no *greater* distance than half a mile between well and well, where there were clay basins, than by the argument that an aqueduct could not be built by people ignorant of arches.

After the conquest we find Atticus Herodes, besides lavishing

his treasures upon other splendid works, bestowing aqueducts as well upon Canusium in Italy as upon Olympia. Modern Thebes is supplied with water, conveyed in channels along the ground from the south-east, passing over the valley to the hill on some modern arches; and at Simopetra, one of the most curious of all the monasteries of Athos is built upon a rock rising out of the sea, and supplied by an aqueduct of three stories of arches, conveying to the monks water from the neighbouring height. On the foot of a small, high, rocky hill, about a mile to the north-north-east of Athens, were four Ionic pillars supporting their entablature. On the frieze and architrave was an inscription divided by an arch, and this epigraph may be supposed to mean that Antoninus Pius finished the aqueduct begun by Hadrian in New Athens.

Nicopolis, in Epirus, possessed two sources of water, which would seem to have been sufficient, with the addition of wells, for the supply of the city; but the colonists were not satisfied with the water, either because it lay too low, or did not suit their tastes, and constructed an aqueduct thirty miles in length. Entering the valley of Nicopolis, on the western side of the hill Mikhalitzi, the aqueduct may be traced by means of long rows of piers across the plain of Lamari, and probably vestiges may be found of others for the passage, across the valley of the Luro, of the conduit constructed along the side of the hills, to a point called The Arches, where will be found evidence of the junction of two aqueducts crossing the torrent Ferekisi. One of these aqueduct bridges is destroyed; the other, though in ruins, is 70 feet high, with a double tier of arches, 18 feet wide. Like some aqueducts at Rome, that of Nicopolis, on reaching the city, ran along the walls, and a very interesting plan of reservoirs or fountains within the walls on each side of the great gate, will be found in the plan of the ruins of the city, contributed by Mr. Donaldson to Leake's *Travels in Northern Greece*, 8vo, London, 1835, vol. i, chapters 4 and 5.

Patras and Corinth were also artificially supplied, as were many towns in the islands of Crete and Sicily; at Agrigentum (Girgenti) are the famous works of Phæax, vaunted by the Greeks as being the first of that nature known, and therefore serving as a model for all others of the kind. Heraclea and Himera were also supplied with water from subterranean conduits, as was Tauromenium (now Taormina), upon whose ancient aqueducts several modern ones have at different times been erected. The supply for Catana was conveyed a distance of ten miles. At Syracuse the conduits were all subterranean, cut in the rock, and intended to bring water a distance of nine miles from a place now called Buccmi; and there are many remains of conduits throughout the island.

The most frequently mentioned of the aqueducts in Sicily is that erected, from his own designs, by Don Ignazio Vincenzio di Castel Paterno, prince of Biscari, about five miles from Aderno, on the road to Centorbi, and serving as the bridge for passengers over the valley of S. Paolo, and the river Symete, now called Regalbuto, a little above the place where it receives the Adriano or Trachino. This viaduct of Aderno is 1540 feet long, and consists of two small, and thirty-one large arches, all semicircular except that in the centre, which is 94 feet span and pointed; over this road runs the channel on forty-seven smaller arches, corresponding in arrangement with those of the bridge (Pl. I, Fig. 12), and extending on each side 3,000 feet beyond it. The greatest height of this work is 128 feet; it was commenced in 1765, and finished in 1777.

ROME.

Some writers have put forward a notion that the Etruscans were the first Europeans to construct these fabrics; if so, the Romans, their pupils, soon surpassed them. Imperial Rome, indeed, at last received 13,773 cubic feet, or 82,500 gallons of water per hour (equal to a current of 30 feet by 3 feet, running with the mean velocity of the Seine at Paris, or 30 inches in a second of time), from three hundred and thirty miles of channel.

That the Roman builders of aqueducts were much better acquainted with the laws of hydraulics than is generally believed, will hardly be questioned by any person, who studies the monuments by the light of the eighth book of Vitruvius, c. 7. There can also be little doubt that the popular ignorance of the sphericity of our planet must have singularly complicated the operations in the field, unless all the aqueduct builders were followers of Archimedes; Vitruvius (viii, 6) certainly did not adopt the theory of the sphere belonging to that school. The apparent errors of the levelling instruments must have therefore given rise to empirical corrections, which would naturally sometimes lead to serious mistakes, thus the number of bends sometimes occurring in a line of aqueduct was doubtless due to a fall which proved, by mistake, so great, as to render it necessary to diminish the velocity of the stream, as well as to prepare to enter into the supply reservoirs at a fixed height by means of the bends in question. The materials at their disposal must also have rendered hydraulic works difficult and expensive; yet in spite of these disadvantages, it may be confidently asserted that wherever the Romans solidly and permanently established their dominion, they hesitated at no sacrifice and allowed no difficulty to interfere with the execution of the works necessary to secure a supply of the purest water, which was brought at the public expense to such positions in the centre of their towns as to enable every citizen to procure, easily and gratuitously, all that was necessary for his domestic wants, in an abundance unknown at the present day; while the magnificence of the empire was attested by the baths, reservoirs, conduits or water-houses, and fountains.

As to their arrangements for the reservoirs at the sources it is unnecessary to say much, as no machinery was used by the Romans; the springs were of course sought at such a level as would allow the water, after running down the necessary fall of the aqueduct, to enter the supply reservoir at the needful height. When the source was gained, then, whether it was a river (*flumen*), an open spring (*fons*), or a supply gained by digging a well (*puteus*), a head was constructed for the water, and enclosed with a wall; of course, the quantity could be increased by making channels to this reservoir from other sources; but if no other supply could be obtained than water from roofs, etc., that was led into tanks built with concrete walls, and so arranged as to form deposit chambers (Vitr. viii, 8).

Having obtained the fountain-reservoir, the water from it was conveyed in a channel, which involved, on the part of the Romans, operations similar in many respects to the works required in the construction of modern railways, with the additional disadvantage, that the line could only allow of a fall one way, and this the ancients sought to form with as slight, and at the same time as nearly uniform, a slope as possible. The inclination allowed by Vitruvius seems to be not less than 1 in 200, while Pliny allows only 1 in 4,800; and the irregularity of the line of some aqueducts could only, as above-mentioned, have been intended to prevent a too rapid flow of the water.

The channel itself, called *forma, cuniculus, specus*, or *canalis structilis*, by the Romans, was a trough (A, B, C, and D, Fig. 11 and Fig. 14) of brick or stone, lined with cement, and covered: and the water either at once ran in this trough, or in pipes laid in it; these pipes were of lead (*fistuli plumbei*), of stone, of terra cotta (*tubuli fictiles*), of wood (*canales lignei*), Palladius, ix, 11; especially of the hollowed trunks of the alder, fir, and pine, Pliny, *H. N.*, xvi, 42, § 81; or even for the sake of economy, of leather, Pliny, *H. N.*, v, 34, § 2.

When the channel was raised above the level of the ground, the ancients had to carry the *forma*, now generally called *specus*, on solid substructions, or on arched fabrics. Whether

the *specus*, or rather *forma*, was above the ground, or a *rivus* on the surface of the earth, whether the *specus* properly so called was carried beneath the surface as a *cuniculus*, a tunnel in rock in which the *canalis* was built, or as a *rivus subterraneus* constructed of masonry passing through sand or clay, it was always covered to exclude the sun, the wind, the rain, and any corruptions or obstructions. It was soon found necessary to provide air holes to prevent bursting, and to make the water pass freely; these vents, *spiramina*, were made at intervals in the roof of the specus, or, if another channel ran above it, in the side; such are seen in the sections of the triple Roman aqueduct (Fig. 11). To ventilate the portion of an aqueduct carried below the surface of the ground, a well (*puteus* of Vitruvius, Fig. 5, representing a common form), was inserted at distances varying from 80 to 120 Roman feet, or 240 according to Pliny, who calls them shafts or *lumina*, (Fig. 6, representing a less common arrangement.) Those wells seen by Pococke at Touma were fifty yards apart, the channel being 10 feet underground. It is remarkable how large a portion of the Roman aqueducts were subterranean, when we consider that although this manner of construction possessed the advantages of being less exposed to the variations of temperature, and more secure from intentional injury, yet it was of course more difficult to reach when reparations were required; the mode of arriving at them by preconcerted openings is shewn in Fig. 7. For the general construction of the *forma*, or *specus*, reference may be made to the aqueducts of Lyons hereafter described.

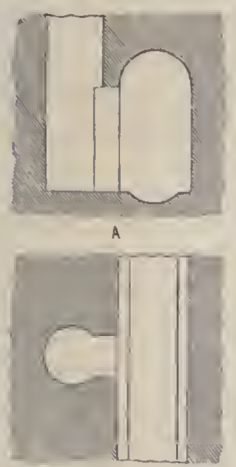


Fig. 6.
A Section; B Plan.


Fig. 5
Section.

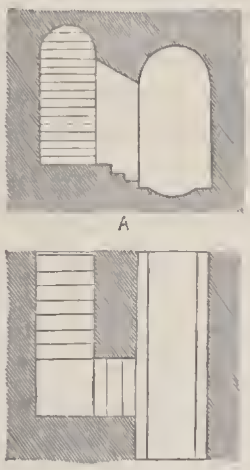


Fig. 7.
A Section; B Plan.

Leaden pipes were perhaps more commonly used than earthen tubes by the Romans, especially for short distances, and considerable ingenuity was shown in their manufacture. Their shape was not perfectly circular, but they were made by turning up plates or *lamnæ* (*laminæ*) of metal, ten feet long, into a form represented by the example, Fig. 8: the dotted lines on the illustration show a mode of fastening the pipes which has been discovered in some ancient specimens. Where strength was required, a capping or ridge was soldered over the joint and hooped round to the pipe, with narrow cuttings of lead. Pliny (xxxiv, c. 48) states that tin was used as the compound to solder conduit pipes, and that the lead brought from England was hammered into sheets for the pipes.

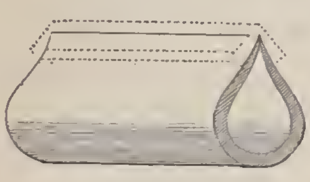


Fig. 8.

The plates were of a given number of sixteenths of a foot (*digiti*) wide, according to the name expressing the size of the proposed pipe. At least this is inferred from Vitruvius, and also that each length of ten feet, at one digit wide, weighed 12 lbs., *i. e.*, the Roman lead for this purpose weighed 19 (or 15, according to Cresy) lbs. to the foot superficial; and that this was the weight for all sizes of pipes, the largest being centenary, and the smallest quinary, of the digits in the sheet. Frontinus, however, entering very minutely into the subject, gives (c. 20-63) other calculations.

When frequent vallies, deep or long, occurred, the pipe-system had the advantage of appearing economical, and of dispensing with an expensive fabric; in such circumstances the pipe was led, (like that at Constantinople above-mentioned, *à souterazici*, viz.,) down one slope, and at the bottom on as long a level substruction as possible, which was called the *venter;* and carried up the opposite slope. Vitruvius directs the use of stand pipes (*columnaria*), to lessen the force of the atmospheric pressure; and recommends placing reservoirs at every twenty-four thousand feet, so that, should an accident occur, the injured place might be found without pulling the whole of the work to pieces; of course these reservoirs could never be in the slopes, or the venter. He also remarks that if the tube had no *venter*, but came down one hill, and merely turned in an elbow, at once to go up the opposite side, the pressure would burst the pipe at the joints.

Very little was known of the stone and earthenware tubes, except from remains in the Thermæ and the Coliseum, until the communications above detailed by Mr. Falkener. Pliny (*H. N.*, xxxi, 6) says that the last are best, when two digits (about one inch and a half) thick; that each pipe should have one end tapering for insertion into the next one; that the joints should be cemented; and that, although lead pipes should be used where the water had to rise in them, that the earthenware was better as being more wholesome. Vitruvius says distinctly that the tubes should be tongued, the joints made with putty, and that at the elbows of the *venter* the pipes should join a perforated block of red (Collatino) stone; for, he says, in aqueducts, a wind is wont to be created, which will even burst the stones, if the water at the first be not softly and sparingly let down from the head, and unless in elbows or bends it be restrained by means of ligatures or a weight of ballast. All other details are similar to those for leaden piping. When the water was first let in, ashes were put into the tube beforehand, so as to stop the joints more effectually if perchance any were insufficient. The same author also dwells upon the superior salubrity and more agreeable flavour of water out of earthen. over that out of metal, vessels.

The extreme attention given by Vitruvius to the subject of the pipes or tubes, may not unjustly lead the reader to suppose, that in the time of that author this method had been chiefly employed; or rather, that the system of building aqueducts upon arches had not yet been adopted to any considerable extent: whence it may also be inferred that experience on a grand scale has already once shown, that such constructions are in many respects preferable to other methods of conducting water, in a country secure from war.

The Romans placed at convenient points, especially near the middle and end of the aqueduct, deposit reservoirs (*piscinæ limariæ, piscinæ limosæ*), for the purification of the water from any sediment which it might hold in suspension; one of these reservoirs is given in Fig. 9: that they were not always used appears from noticing that the Aqua Virgo and Aqua Alsietina did not possess them; indeed they were chiefly necessary when the water ran through pipes.

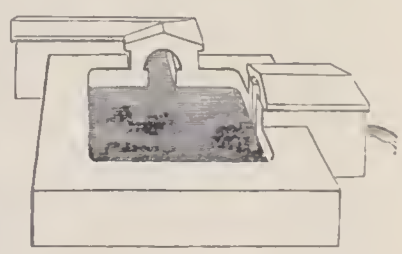


Fig. 9.

The *castellum* was the supply-reservoir, and there is a little difficulty in this term, which may be obviated by dividing it into two classes, major and minor. The larger piscinæ also served as reservoirs for the adjacent country, for the purposes of irrigation, etc., and were properly *castella* if above ground, *piscinæ* on the level of the soil, and *cisternæ* if sunk in the earth. In all cases they should be understood to be covered with a vaulted roof, sometimes supported by pillars, like the remarkable examples at Constantinople.

These reservoirs were formed by one or more chambers, *conceptacula*, one of the usual arrangements is shewn in Fig.

10, where the water of the Aqua Virgo flows into A, sinks into B, and passing into C, rises to its level in D, whence it resumes its flow in the conduit. Among the great reservoirs of Rome may be counted that near the Colosseum, another near the Porta Maggiore (both supplied probably from the Aqua Claudia), another of nine cisterns, com-

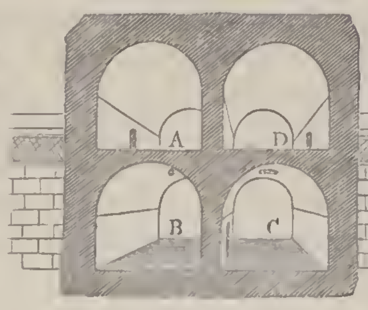


Fig. 10.

monly called the Sette Sale, near the Baths of Titus, and another for the Baths of Helena under the Villa Conti. The reservoir of the Aqua Marcia, called the Cento Celle, is situated between the Marcian and Claudian aqueducts, about four miles from Rome on the Via Latina. All the aqueducts which had *piscinæ* were measured within seven miles of the city; and this leads to the consideration of the minor *castellum*, chateau d'eau, conduit, or water-house, of which the more ancient name in use when the aqueducts were first constructed was *dividiculum* (FEST., I, 5): into this the water flowed from the main or branch conduit, and was conveyed from it through pipes of fixed dimensions into three smaller *receptacula*, so arranged that one was supplied by the overflow of the other two; which supplied respectively the baths, and private houses, while the third was devoted to the public ponds (*lacus*) and fountains (*salientes*): thus in case of scarcity luxury would first suffer, and at all times an account would be kept of the quantity supplied for private use, so as to decide the amount of revenue to be derived from this source. The Trophies of Marius, supplied by the Aqua Julia, may be taken for an example of the *dividiculum;* it is given by CANINA, as restored by the modern architects, Plate CLXXI.

The *castella* were further divided into classes, viz., those for the supply of the Prætorian camp; of the *lacus* and *salientes;* of gifts to the public, as Naumachiæ, etc.; of public wants, as baths, dyers, fullers, etc.; of the prince; and of gifts to individuals.—FRONTINUS, III, 78-86.

Fig. 11 shows a *castellum* attached to the Aqua Marcia, C. The water flowing into a chamber descends into a lower one, supplying the Rivus Herculaneus, D. The *castellum privatum* was for the supply of private houses, and it was built at the expense of the families supplied by it; but it was considered public property, and was under the control of the *curatores aquarum.*—FRONTINUS, 27, 94-111. The *castellum domesticum* was the leaden cistern which each person had in his own house. The details of these points and of the establishments devoted to the care

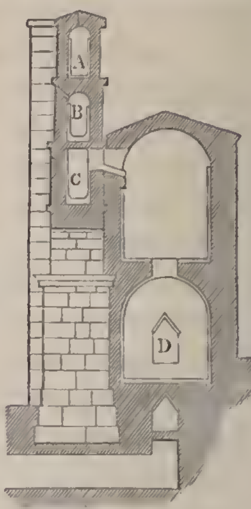


Fig. 11.

of the aqueducts, are given, *sub voce*, by SMITH (*Dictionary of Greek and Roman Antiquities.* 8vo. Lond., 1849).

The writers on the present subject have generally proved themselves descended from one common origin, viz., FRONTINUS, who, about the year 98, having received from the Emperor Nerva the charge of superintending the water supply and service of Rome, was impelled to write his observations after a minute investigation of the sphere of his new duties, in which he was to be assisted by two architects and several subordinates. Following his own system, attention will first be given to the various aqueducts themselves, and afterward to some of the results of his examination.

In order to show clearly the number and names of the aqueducts of Rome mentioned by various authors, the following table has been prepared. Those of the present day are so intimately connected with the ancient works as to render it necessary to consider them at the same time.

Date. (about) B. C.	Twelve of Frontinus. 1st century.	Fourteen of Procopius. 3rd century.	Nineteen of the Notitiæ Dignitatis Imp. Occ. 4th century.	Twenty of Aurelius Victor. 5th century.	Four of 19th century.	BUILDER.	On the Ground. Miles.	Arcades. Miles.	Total Above Ground. Miles.	Total Under Ground. Miles.	Total Length. Miles.	SOURCE. (NEAR.)
312	Appia	Appia	Appia	Appia		A. Claudius Crassus / C. Plautius Venox	..	0·060	0·060	11·130	11·190	7 m. of V. Prænestina
										6·380	6·380	A branch
272	Anio vetus	Anio vetus				M. Curius Dentatus / M. Fulvius Flaccus	..	..	0·221	42·779	43·000	Tivoli, about 20 mile of V. Tiburtina
145	Marcia	Marcia	Marcia	Marcia		Q. Marcius Rex	0·528	6·935	7·463	51·247	61·710	36 m. of V. Sublacensis
										0·800	0·800	Branch near the head
126	Tepula	Tepula	Tepula	Tepula		C. Servilius Cæpio / L. Cass. Longinus	..	..	..	..	..	10 mile of V. Latina
31	Julia	Julia	Julia	Julia		M. Vipsanius Agrippa	0·528	6·472	7·000	8·426	15·426	12 mile of V. Latina
	Crabra	Crabra	Damnata	Damnata	Marrana		..	..	..	..	..	15 mile of V. Latina
22	Virgo	Virgo	Virgo	Virgo	Vergine or (Trevia, 1447-1570	M. Vipsan. Agrippa / Nicholas V & Pius V)	0·540	0·700	1·240	12·865	14·105	8 m. of V. Collatina
21	Alsietina, quæ et Augusta	Alsietina	Alsia Alsietina Setina	Alsia, sive Alsientena, quæ et Augusta		Augustus	..	0·358	..	..	22·172	At Lacus Alsietinus
21	Augusta		Augusta			Augustus	..	..	..	..	0·800	Source of Marcia
A.D. 36	Claudia	Ciaudia	Claudia	Claudia		Caligula and Claudius	0·609	9·567	10·176	36·230	46·406	38 m. of V. Sublacensis
51	Anio novus	Anio novus				Claudius and Nerva	..	..	9·400	19·300	58·700	42 m. of V. Sublacensis
51-68	Neroniana					Nero	..	1·261	1·261	..	1·261	From Claudia and Anio Novus at Porta Maggiore
112		Trajana	Trajana	Trajana		Trajan	..	..	..	..	33·000	At Lacus Sabatinus
203		Septimiana		Septimiana		Septimins Severus	..	..	..	..	..	From Trajana
203			Severiana	Severiana		Septimius Severus	..	..	..	..	9·000	Li Fratocchi
211			Antoniniana	Antoniniana		Caracalla	..	..	..	..	..	From Marcia
212		Algentiana		Algentiana		Caracalla	..	..	..	..	16·500	Mons Algidus
226		Alexandrina	Alexandrina	Alexandrina		Alexander Severus	..	..	..	..	14·000	Ponte Sicala, near 14 m. of V. Prænestina
274			Aurelia	Aurelia			..	..	..	..	..	From Trajana
			Annia	Annia			..	..	..	..	..	
			Ciminia	Ciminia			..	..	..	..	..	At Lacus Ciminius
			Herculea	Herculanea			..	..	..	..	..	From Marcia
500				Sabatina		Symmachus	..	..	..	..	..	At Lacus Sabatinus
				Cærulea			..	..	..	..	..	Branch of Claudia
1585-90					Felice or Sistina	Sixtus V	..	7·000	7·000	15·000	22·000	14 m. of V. Prænestina
1612-74					Paola	Paul V & Clement X	..	..	..	..	..	At Lago di Bracciano

As the aqueduct is often simply called *aqua*, so the *aquæ* have often been supposed to be aqueducts; this however is not the case. The fountains, etc. (*salientes, lacus*), appropriated the name, as the Aqua Jovia, Juturnæ, Mercurii, etc. Auxiliary sources to the great aqueducts also enjoyed the same title of *aqua*, as the Albudina, which belonged to the Claudia; the Augusta, which was applied to a part of the Appia, the Claudia, the Marcia, and of the Anio Novus; the Cærulea, also Cyanea, supplied the Claudia, as did also the Curtia; and one Herculanea was a source of the Anio Novus.

Parts of some of the leading aqueducts took a separate name. Thus one Antoniniana was a branch of the Marcia at the arch

over the Via Collatina, to supply the baths of Caracalla; another Herculanea was a rivus of the Marcia, supplying the Cælian Hill; the Octaviana was a part of the Anio Vetus, and ran from a piscina two miles distant from Rome, over the arch of Drusus into the region of the Via Nova; and the Septimiana, derived from the Anio Novus, supplied (Fabretti) the village now called Statuario, but Cassio calls the supply, the Severiana.

Critics are not agreed upon the precise locality of the Amnia or Annia, which was probably the Anio Vetus; or of the Capitolina; the Labicana; the Petronia; the Salonia; the Setina; the Severiana. Several of the leading aqueducts were certainly known by more than one name, thus the Aufeja (not Anpeja) was the old title for the Marcia; Augusta is a title given to the Alsietina, as being a work of Augustus; Aurelia was Trajana; Cælimontana was the water carried by the Neronian arches; Damnata was an epithet given to the Crabra; Ciminia and Sabatina seem to have been the Trajana; and the same event has occurred in modern times, for the Sistina is another name for the Felix, as the Trevia is for the Virgo.

Aqua Alexandrina ran in its own aqueduct on handsome arches, erected by Alexander Severus to supply the baths built by him next to those of Nero, near the present Piazza Madama. The source was gained in the lands of Tusculum, about fourteen miles from Rome, between Gabii and Lake Regillus; and Fabretti wrote his learned treatise to prove that the reservoir of the Acqua Felice received its supply from the same springs as those which had formerly filled the Alexandrina. Considerable remains of the *opus arcuatum* still stretch across the Campagna, and appear to be composed entirely of beautifully worked brickwork, in arches of a single (Roman) brick ring, when low and near the source, as in the valley of Pantano, where their span is about 10 feet 6 inches, and of a double course everywhere else; the height being sometimes 70 feet and the span of these arches 12 feet; where the height was too great for a single arch, the aqueduct was constructed in two tiers of arcades; each arch having a *supercilium*, or tile cresting, by way of hoodmold or architrave. (Plate II, Figs. 12, 14 and 15.) Fabretti gives its elevation, piscina limaria, puteus, and spiramina. The piers, which are eight feet square, are built of concrete, faced everywhere with brick: the work is much dilapidated, and in some places the *specus*, or rather *forma*, has been taken off, and the Crabra led in a *rivus* dug in the mass, but in a contrary direction to the original fall. The *forma* or channel was 2 feet 6 inches wide and 4 feet 6 inches high to the springing of the vault, whose rise was 1 foot 3 inches; the side walls were 2 feet 3 inches thick.

A. Algentiana is stated to have come from Mons Algidus, a course of about sixteen miles and a half: according to Fabretti, the aqueduct first appeared about nine miles from Rome, and passed by the Torre Mezza via di Frascati, where there remains a part in arcades: the builder is unknown, but Cassio suggests Caracalla.

A. Alsia is Alsietina, or rather one half of the word supplying the deficiency of Setina in the list of the Notitia. The Alsietina, also called Augusta, was on the right bank of the Tiber, and was brought, although the water was very bad, from the Lacus Alsietinus, now Lago di Matignano, which lay 6,500 paces to the right hand of the fourteenth mile-stone on the Via Claudia, by Augustus, for the supply of his Naumachia in the Trastevere. Its aqueduct, rediscovered in 1720, was 22,172 paces long, of which 358 were in arcades built of tufo. It was restored by Trajan, who introduced the Ciminia and Sabatina, or Trajana, near Carejas. The great reservoir of the Alsietina was 1,800 feet long by 1,200 feet wide.

A. Anio Novus was originally built by Claudius, and was taken, as Frontinus observes, from the river of the same name, which running in a rich soil amongst cultivated fields, was always troubled and charged with mud during the rainy seasons: although a *piscina limaria* was constructed at the entrance of the river water into the aqueduct, yet whenever there was rain, the supply was always troubled on its arrival in the city; Nerva therefore ordered a fresh supply to be sought twenty-two miles further away from Rome, and thus this became the longest of all the aqueducts in the Campagna. It began at the forty-second milestone on the Via Sublacensis, and at the thirty-eighth received the Rivus Herculaneus; Fabretti questions whether the Septimiana was not derived from it: besides supplying Rome, the Anio Novus supplied a village in the place now called di Sette Bassi, by a series of arches 600 paces long. Its total length was 58,700 paces, of which 9,400 only were above ground, and of these last 609 near the city were substructions, and 6,491 in arcades; the remaining 2,300 among the hills being partly arcades and partly substructions. The Anio Novus ran just over the Claudia, on the same arcades near Rome, but before it arrived at the piscina or castellum where it was measured out, it was everywhere forty feet above it; the arcades are the highest in the Campagna, being in some places 109 feet above the level of the ground. Its channel may still be seen above that of the Clandia in the Porta Maggiore, where Vespasian and Titus are mentioned in inscriptions as having restored it.

A. Anio Vetus was begun, B.C. 272, by Manlius Curius Dentatus, and finished by Marcus Fulvius Flaccus, with the proceeds of the spoils taken from Pyrrhus: it commenced at the twentieth milestone on an ancient road above Tivoli, and supplied the Tiburtines with a portion of its current. The aqueduct called Octaviana also drew its supply about two miles from Rome from this channel, while the true Anio Vetus ran near the temple called Spes Vetus, within the Porta Esquilina. In order to maintain the level of its stream, the length of the aqueduct was 43,000 paces, of which 221 were above ground. There are considerable remains of this aqueduct near Tivoli, and on the walls of Rome; it was built of peperino, and the channel lined with a coating of cement. The Anio Vetus was crossed by the Marcia, having a difference of six feet between their levels at the corner of the streets leading from the Circus to the Porta Ostiensis and to the Church of S. Balbinus.

A. Appia was the first aqueduct constructed by the Romans, who until the year 313 B.C. had been content with water drawn from the Tiber, and from a few wells within the city; but in the subsequent year the necessary works were commenced, in consequence of the exertions of the censor Appius Claudius Crassus, who had for his colleague C. Plautius, surnamed Venox, on account of his skill in discovering veins of water for this supply: consequently the Romans did something more than simply lay prone upon the ground an hour before sunrise, as Vitruvius mentions. This construction began in the domains of Lucullus, now Casal di Rustica, about 780 paces down a bye road on the left hand, between the seventh and eighth milestones on the road to Præneste; and ran 11,190 paces to the Salinæ near the Porta Trigemina, in a subterranean channel, except for about 60 paces in arcades near (not upon) the Porta Capena. Two other springs or brooks united themselves to this supply, one being 980, and the other 6,380 paces long; and this last was one of those called Augusta. The *specus* and *canalis* of the Appia, as discovered about the year 1680, are given by Fabretti.

A. Ciminia probably ran from the Lacus Ciminius, now Lago di Vico, near Ronciglione, into the Alsietina.

A. Claudia, the best in quality after the Marcia, was founded by Caligula and finished by Claudius, A.D. 51. Its sources were the Fontes Cærulea and Curtia, about 300 paces down a bye road near the thirty-eighth milestone on the Via Sublacensis, and in its course it also receives the streamlet Albudina: there was also a feeder called Augusta, which served both this and the Marcian aqueduct. This work was 46,406 paces long, of which only 10,176 were above ground, 609 being substructions, and 9,567 on arcades. Of this magnificent work, a line of arcades no less than six miles in length, built of squared stone, still bestrides the Campagna, forming the grandest ruin beyond the walls of Rome. Its specus was 4 feet 2 inches wide by 6 feet

high, with sides 3 feet thick: its arches were 21 feet span, on imposts projecting 1 foot 6 inches from the piers, which were 14 feet on the face, and 12 feet deep, with only 20 feet between the imposts: the arch itself was 10 feet 6 inches deep from front to rear, and 2 feet 9 inches in thickness. Stone was the only material of construction. The Anio Novus ran above it near Rome: Septimius Severus and Caracalla are recorded as having restored it; and pope Sixtus V availed himself of the arches for his Acqua Felice. A branch ran from the Claudia to near the sepulchre of Cæcilia Metella; and FABRETTI saw portions of its ruins at Acqua Santa, formerly Ad Camœnas: and the water which ran on the Arcus Neroniani also came from the Claudia.

A. Crabra was a subterranean channel, whose source was near that of the Julia, and it was originally carried right through the Circus Maximus, although the water was so bad that, as Agrippa would not bring it into the Julia, it was called Damnata: in later times it was carried on part of the line of the Alexandrina, and, under the name of Marrana, received the water of the Julia and Tepula. The traces of the channel begin at Li Centroni, nine miles on the Via Latina.

A. Felix or Felice was so called by pope Sixtus V, not so much from the success which attended its construction, as from his name (Felix) before the pontificate. It rises near the Osteria di Pantano, about fourteen miles out of Rome on the road to Palestrina, where FABRETTI places the source of the Alexandrina also, and runs in a subterranean channel to near the Torre Mezza Via di Frascati, where it takes the Claudian aqueduct.

A. Julia was conducted to Rome B.C. 34, 35, or 37, by M. V. Agrippa, from a source very near that of the Tepula, two miles to the right of the twelfth milestone on the Via Latina, in an aqueduct 15,426 paces long; 7,000 paces being above ground, of which 6,472 were in arcades. It is supposed to have run first to the Tepula, and to have been merged in it as far as the reservoir on the Via Latina, seven miles from the city. Thence it was carried along two distinct channels on the same substruction, which probably was that of the Tepula restored; the lower being called Tepula, and the upper Julia; and these again ran on the Marcia after the junction of all three at the Porta S. Lorenzo. In walking along the Via S. Bibiena towards the church of S. Eusebio, six of its arches may be seen on the right hand, and some remains on the left. It supplied the *dividiculum* called the Trophy of Marius, which also served for the Claudia and Julia. Its traces are nearly lost after its junction with the Felix.

A. Marcia, once called Aufeja, was conducted to Rome B.C. 145. An aqueduct with an unusually large canal was desired, and 8,400,000 sesterces (£45,700) were granted to Quintus Marcius Rex for its execution. Its source was the Fonte della Mola, "Fons ipse Pitonia" of Pliny (xxxi, 3), at the extremity of a byeway 3,000 paces long, which met the Via Valeria on the right hand, and the Via Sublacensis on the left, at the thirty-sixth milestone on each. Antoninus Pius added to the supply a spring called Augusta, afterwards turned into the Claudia, and the branch called Antoniniana was an addition at the arch over the Via Collatina, made by Caracalla to supply his baths. The total length of this aqueduct, from its source to the city (Rome), was 61,710½ paces; 54,247½ in subterranean conduits, and 7,463 in substructions above ground: of these, 463 paces were arcades in the several places where the valleys occurred, 528 formed a canal above ground, and the remainder, or 6,472 paces, expressed the length of the arcades near the city, necessary to conduct the water to the Capitol, the most elevated spot in Rome.

This portion is that magnificent line of arches, which still forms so grand a feature of the Campagna, and many persons see in it the style of construction practised in the time of the Republic; but there are strong reasons for believing that, except the foundations, the greater portion of the existing work belongs to the time of Augustus, who repaired all the aqueducts of his era; in fact, it is almost impossible to distinguish the original from the additions and restorations made during the early period of the empire. The rivus, 2 feet 6 inches wide by 5 feet 6 inches high, with sides 1 foot 3 inches thick, was restored by Titus. The arches now standing are built of peperino. Near the Arco Furbo, on the road to Frascati, the aqueduct is crossed by the Claudia, which runs parallel to it in some places. The Marcia crosses, at a height of 6 feet, the Anio Vetus, at the angle of the streets leading from the Circus Maximus to the Porta Ostiensis and to the church of S. Balbinus, and close by that place the Appia was seen 28 feet below the Anio Vetus. The Marcia stopped upon the Porta Capena; but a portion ran to the Cælian Hill, in the *rivus* called Herculanea, after leaving the Pallantine gardens. The water of the Marcia now runs into the Virgo or Trevia.

A. Mariana, probably a misprint for Marrana, is the Crabra and Damnata, which rises near Marino and Grotto Ferrata, and falls into the Tiber after running through the Circus Maximus.

A. Neroniana, or Cælimontana, is a convenient appellation for a branch of the Claudia after the Anio Novus had been joined to it in the time of Nero, and mentioned by FRONTINUS as commencing "ad Spem Veterem", which must therefore have been from near the Porta Maggiore, where its admirable construction in the "lateritia" or brick work, so highly praised by Vitruvius, will be best seen and appreciated; taken as a specimen of the age of Nero, Rome at this day offers nothing parallel. The specus is 2 feet 6 inches wide by 5 feet 6 inches high to the springing of the vault, which rises 1 foot 6 inches higher, the sides are 1 foot 7½ inches thick, on an arcade consisting of arches varying in span from 18 feet 6 inches to 27 feet 6 inches; the inner ring of the arch was 2 feet deep, the outer ring was 1 foot 3 inches, projecting to form an archivolt; the piers were 7 feet deep by 8 feet on the face. From the Porta Maggiore, the arches may be followed in continued preservation to near the "Santa Scala", and again partially across the Piazza Laterana; they are seen again in the deserted Via S. Stefano, and finally in the Piazza Navicella, near which place as a continued aqueduct it ended. But from the place where FRONTINUS says it thus ended, there began other branches, which conveyed the water to the Palatine and Aventine hills, and even across the Tiber; of these branches, some remains projecting from the mass of the stupendous ruins of the palace of the Cæsars towards the Cælian hill, may have been one, made or repaired after the time of Nero. The above described great work was properly known by the name of the Neronian arches, doubtless because it was first constructed by Nero, for the purpose of conveying water to his golden house and extensive gardens. Its original appellation does not seem to have long survived the tyrant; for it appears by an inscription given by GRUTER, (tom. i, p. 187,) that Septimius Severus repaired the aqueduct then called the Cælimontane Arches. In the solitary Via S. Stefano will be remarked the solid construction of the aqueduct, and with a little consideration the repairs of Severus will be easily distinguished from the original work of Nero. In the gardens of the convent of the Passionists may be seen the termination of the aqueduct; also some additional arches of a date posterior to Nero's work, these are perhaps some of the repairs made by Septimius Severus. Its *piscina* or *stagnum* is carefully detailed by BURGESS.

A. Paola consists of the water gathered from the territories of Arcolo and Baccano, which were conducted in the ancient aqueduct of the Alsietina by Paul V, under the direction of Giovanni Fontana; afterwards a new supply from the lake Bracciano was added to it by Clement X, in 1674, under Carlo Fontana. About one-third of the quantity of water furnished goes to the Vatican, where it supplies the fountains of the Piazza di S. Pietro, and those of the Pontifical palace; the remainder is distributed in eight public, and twenty-three semi-public fountains, and in twenty-one taps in the Via S. Pancrazio.

A. Tepula was introduced by Cneius Servilius Cæpio, and Lucius Cassius Longinus, B.C. 126, from a source near Tusculum; after it joins the Felix its traces are nearly lost.

A. Trajana, which entered the Porta S. Pancrazio after a course of two miles along the Via Aurelia, was probably the Sabatina, Ciminia, and Alsictina in one channel.

A. Virgo was conducted to Rome, according to Frontinus, about the year 22 B.C., by Marcus Vipsanius Agrippa. In the city it was conveyed on arches, commencing in the gardens of Lucullus and ending in the Campus Martius, in front of a public building called the "Septa", and from thence supplying the baths of Agrippa: the date (9th July) has been preserved on which the water reached the city. This aqua, which now supplies the Piazza di Spagna and the Fountain of Trevi, has its source near the river Anio, about eight miles from Rome, on the left hand of the ancient Via Collatina; where its springs are enclosed within a space formed by brickwork covered with cement. It is augmented by other veins, and arrives at Rome by a channel 14,105 paces in length, 12,865 being subterranean works, and 1,240 above ground; of these 540 in various places were substructions and 700 in arcades: 1,405 paces more must be added for the underground channels belonging to the minor conduits. This water, in its passage, runs through the garden belonging to the church of S. Trinita de' Monti, at an immense depth; it is possible to descend to it, but with considerable difficulty. The arches described by Vitruvius therefore began where the water issued from the Monte Pincio, and they may be partially traced from there to the fountain of Trevi. The conduits or channels of the Aqua Vergine or de' Trevi having been damaged, its repair was commenced under the pontificates of Nicholas V and Sextus IV, and finished under Pius V in 1570. In continuing along the Via della Stamperia, vestiges of the original aqueduct may be traced behind the houses on the left-hand side of the street; but attention will chiefly be directed to a portion of the arches mentioned by Frontinus, which remain unimpaired since his time. In the Via del Nazareno, one side of the arches may be seen by descending into a washing-house; but the other side remains still more perfect in the court-yard of the Palazzo del Bufalo, which is situated nearly opposite the entrance into the Collegio del Nazareno. The large and legible inscription written upon travertine stone, and given by Burgess, shews that Claudius restored these arches from the foundations after their dilapidation by Caligula.

For details of the leading aqueducts, and for a map of the Campagna showing their probable course, etc., the reader is referred to Rondelet's edition of Frontinus.

The levels at which the several conduits delivered their water, *i.e.*, the different heights of the aqueducts, were ranged in the following order by Frontinus; the mean level of the Tiber is 91 feet 6 inches above the sea, according to Cresy (*Encyc.*), from whose measurements compared with those of Fabretti, it appears that the following are the actual heights of the bottom of the channels above the datum line of the Tiber above given. Anio Novus, 158·88 feet; Claudia, 148·9 feet; Julia, 135·5 feet; Tepula, 130·7 feet; Marcia, 124·5 feet; (these three arrived at the city in one aqueduct); Anio Vetus, 82·5; Virgo, 34·2; Appia, 27·4; Alsictina was still lower. The top of the external covering of the Aqua Felix is 5·79 feet below the bottom of the Claudia; according to Genieys, the Paola is 210 feet, and the Felix 176 feet above the summer level of the Tiber.

Six of these aqueducts were led to covered reservoirs, termed *piscinæ*, near the seventh milestone on the Via Latina, in which to deposit their sediment; the quantity of water being also then determined by the measures placed there;—neither the Virgo, Appia, nor Alsictina had this sort of reservoir. These last streams being of inferior quality, were only used by the Romans for the gardens, for cleaning and watering the streets in summer, and for similar common purposes. The use of these reservoirs is rather remarkable, because, had the aqueducts been constructed with wells, there would have been no need of reservoirs, which were at any rate insufficient to render the water as clean as it might be; and Frontinus was himself perfectly convinced of this fact.

I have myself constructed a little conduit in earthen pipes, of about 700 feet long, at Weesp, a small town about nine miles from Amsterdam, on the banks of the river Vecht, whence the needful soft water is brought to Amsterdam in boats: and having constructed in this length of pipe five such wells, I have found by experience that the water was delivered extremely pure, even when it was troubled in the river at the head.

After having mentioned the duties of the public towards the aqueducts, Frontinus relates the duty of governments as regards their surveillance and repair. The paragraphs following the above, namely, the 121, 122, and 123, are sufficiently important to be given entire.

"The aqueducts generally fail through age and violence of storms; especially when they are carried upon arcades, or when they are built on the sides of hills. The portions in arcades which suffer most, are those which span the rivers. The subterranean channels suffer less, because they are not exposed either to frost or great heat. The repairs to be made to the channels are sometimes occasioned by the sediment attaching itself to the walls, and in time forming hard and thick concretions which obstruct the passage of the water, or sometimes by the failure of the linings, which occasions leakages, to the damage of the walls of the channel and the supporting masonry. The piers supporting the aqueducts should not be built with tufo, because this material crushes under such a weight. Although the right season for building operations is from the beginning of November to the end of March, it is proper to suspend the repairs during the height of summer, because great heat is not less injurious than frost, and it is desirable to have a moderate temperature, while all parts of the masonry are obtaining the necessary solidity, and because the stream should not be interrupted in summer when water is most wanted." The acts or decrees collected at the end of the *Commentaries* are interesting, and the reader is referred to them and to Poleni.

The aqueducts of Rome seem to have engrossed all the attention of travellers, and little consideration has been paid to other ancient works of similar character in Italy. Canusium owed its aqueduct to the munificence of Atticus Herodes; there are ruins of an imperial aqueduct between Laurentum and Decimo; and between Ostia and Malafede; Trajan built one to his dockyard opposite Isola Sagra, and another, a remarkable work by which water is conveyed from the Mignone, a distance of twenty-three miles, to Civita Vecchia. Augusta Bagenniorum, now represented by Bene and Roveglia in Piedmont, lost its aqueduct in the invasion by Alaric; the ruins are still visible; and four arches of a massy but elegant aqueduct, are the most conspicuous of the few remains which have escaped the destruction of its sister city, Aqua Stratelliorum (Acqui), to attest its ancient magnificence. Marzana, in the vicinity of Verona, also boasts of the ruins of a Roman aqueduct. This last structure closes the list of important works of this class in Italy, properly called Roman. The aqueduct called della Torre, of Spoleto, is never attributed to an earlier age than that of Theodoric, who died A.D. 526. It crosses the deep valley separating the almost insulated hill on which the city is built, from the opposite mountain, and serves both as an aqueduct and as a bridge over the torrent Morazia, supported by a range of ten great pointed arches, each 66 feet 11 inches span, on piers of 10 feet wide by 40 feet thick. Calindri, the celebrated engineer of Perugia, states, in his *Saggio Statistico-Storico*, that it was built by Theodelapius III, Duke of Spoleto, in 604. The same authority gives the height as 263 feet, and the length as 676 feet; scarcely any other account agrees with these dimensions, which have been stated at 308 and 420 feet for the height, with 761 and 800 feet for the length. The height given includes the thirty smaller pointed arches (rising nearly 80 feet according to the highest statement) upon which the channel is placed. The

whole structure, even taking the smallest dimensions, is an example of boldness in design (Plate III, Fig. 13) and of perfection in execution, calculated to give a very high idea of the skill of the builder; and the style of this aqueduct, as well as of the example from Constantinople, has helped to embarrass all those who have written upon the origin of Gothic architecture. It bears however sufficient evidence of repairs and additions made long subsequent to the Lombard times, whence, its substructions and the body of its nine piers are perhaps all that can safely be regarded as belonging to the original structure.

Of the modern aqueducts in Italy, the most famous is that at Caserta, about fifteen miles from Naples, built by the architect Vanvitelli, under the orders of Charles III, King of Naples, about 1750, where, in finishing the environs of the palace, vast waterworks were necessary to comply with the reigning fashion. The gardens are situated twenty-seven miles from the springs: the principal of these is the Sorgente dello Sfizzo, to which are joined several others from Airola, and these, united in one conduit, cross the river Faenza by a bridge of three arches. To cross a torrent between S. Agata dei Goti and Durazzano, a similar bridge was required; but afterward, to cross the deep valley between Montelongano and the Tifata hills, larger constructions were requisite. They consist of three stages of superimposed arcades; the lower is formed by nineteen, the next tier has twenty-seven, and the uppermost forty-three, arches, which are the loftiest; the total length is 1,618 feet, and 176 feet in height. At the ground the arches are twenty feet in span, and the alternate piers, which are as much in depth, have buttresses projecting six feet. (Plate II, Figs. 5, 6.) The piers in the second range are twelve feet in depth, and in the third story nine; the buttresses retain their original amount of projection before the face of the piers, through a battering from the level of the impost of the arches in the lowest tier. The passage worked in the piers over each story is four feet wide. The open canal in which the water runs is five feet wide by about three feet six inches high; and the body of water averages a height of about two feet six inches. The entire length of the aqueduct from its head being 126,798 feet; the fall 26 feet 5 inches is only equal to $\frac{1}{4,800}$ or $2\frac{1}{2}$ inches in 1000 feet.

One reason for the adoption of so little fall might be the acquaintance of the architect with the minimum above mentioned as allowed by PLINY; as the channel is open, and as rivers rarely have more than $\frac{1}{200}$ of fall, Vanvitelli probably supposed that the slope selected would be sufficient, because the quantity of water required at Caserta was not very great; and with a more rapid fall, he would have been obliged to have resorted to regulating machinery at the head, to prevent an overflow of the distributing reservoir; in that case the water would never have been so fresh and so sweet as if it were always in motion along the channel, which would have been heated by the sun while it was empty.

The subterranean works necessary to the construction of this aqueduct, were even more considerable than those above ground; it was necessary to pierce through the hills five times,—the first at Grato, in the tufo for 6,600 feet; the second at Crisco, in the solid rock for 5,700 feet; the third in the Montagna della Croce, for 2,100 feet; the fourth at Gezzano, in the solid rock for 3,540 feet; and the last at the hills near Caserta, for 1,380 feet. To give light and air to the subterranean canal, wells have been sunk, some of which are 250 feet deep, with diameters of 10 feet at the bottom and 4 feet at top.

"In the Piazza Maggiore of Olevano (near Palestrina), is a fountain, with a mutilated inscription recording the formation of an aqueduct by Pope Pius VI (1774-99), and its restoration in 1820 by Benedetto Greco 'for the love of his country'.

"The road from Civita Castellana, shortly before entering the walls of Nepi, passes a magnificent aqueduct of two tiers of arches, built by Pope Paul III (1534-50)."—MURRAY.

The aqueduct of Civita Castellana (Plate II, Fig. 7), in the part giving to it its reputation, is built upon an ancient bridge which was a portion of an old road. The causeway itself is about 768 or 820 feet long by 30 or 32 feet wide; the greatest height being 120 or 130 feet, which is carried by nine arches, three of which are 78 or 86 feet, and the others 60 or 64 feet each in span. The piers are strengthened by buttresses, and upon this bridge is constructed the arcade for the aqueduct, about 57 or 65 feet in height, of arches 19 or 20 feet span. The precise date of this addition is not known, but it is presumed to be of the middle ages. The dimensions vary according to different authorities.

Leghorn is supplied with water brought from Colognole, and the aqueduct, erected in 1792, which, in one portion where it crosses the valley is upon the Roman model, is a fine work, in which a certain degree of dignity is joined to utility.

Leaving Loreto, on the road to Recanati, the traveller passes, at a short distance from the town, a fine aqueduct, stretching across the valley from hill to hill, and communicating with the subterranean channels by which Loreto is supplied with water: the work was commenced and completed by Pope Paul V (1605-1621), at an expense of £40,000.

The water of the Arno is not considered wholesome, and that of the wells and springs near the city of Pisa is hardly drinkable. This inconvenience, however, has been entirely removed by the care and munificence of Ferdinand I and Cosmo II in making (1606-13), at a cost of £35,000, a watercourse from the Monte Pisano, where two springs are led into one generally subterranean vaulted channel, which on account of the level passes in some places at about three feet above ground. There are eight deposit-reservoirs in the course of this aqueduct, the most remarkable of which is one of marble at the village of S. Rocco: thence, 958 arches, each about 16 feet span, conduct the supply to Pisa, where it enters on the south-west side of the city at a height of forty feet, after a course of about four and a half miles. The arcade has acquired a most deceptive colouring of antiquity, and it is curious to contrast the science and skill of this aqueduct, called of Asciano, completely an imperial Roman work both in design and execution, with the simplicity of its contemporary, the New River at London.

For the city of Lucca, Notolini erected an aqueduct in 1833-1835. Commencing in the hills of Vorno, near Torringo, the sources of the brooks are conducted by sixteen bronze pipes into a subterranean channel, which joins an aqueduct on arcades, numbering 459 arches, up to the place where the water falls into a marble basin, surrounded, or rather formed by a sort of monopteral temple, whose cupola is sustained by twelve monolithic Doric columns. The length of the arcades is 11,624 3 inches, the span of each arch is 17 feet. The width of the piers is 7 feet 8 inches, and their depth 12 feet 6 inches The water channel 2 feet $2\frac{1}{2}$ inches wide, and as much in height, is divided into two streams, so as to assure a constant supply in case of any accident to either of them, and to convey separately the best water for drinking. The greatest height above ground of the arcades is 59 feet, and the least is 25 feet 6 inches; and near the city, facing the gate S. Pietro, about 37 feet. All the arches are constructed in brick, upon stone piers. From the basin placed in the monopteron the water falls perpendicularly into cast iron pipes, to be conveyed to the city by similar horizontal tubes laid in the ground. This sumptuous and useful monument, which cost £45,207, is equally glorious to the Duke Charles Louis and to his engineer.

In A.D. 1276, the engineer Bocca Négro commenced the construction of an aqueduct destined to carry soft water to Genoa. It was commenced in the valley of the Vento, but the works having been interrupted, it remained unfinished until 1636, when Giovanni Aicardi completed it. The water, from the sources of the torrent Bisogno, is at first led into a subterranean channel, but nearer the town in crossing the valleys it is supported by arcades. The syphon-bridge, which traverses

the valley of Cavarola, is the most considerable of this work, although only 215 feet long; but its highest arches give an elevation of 100 feet. (Plate III, Fig. 1, and Fig. 12.) The subterranean portion is made of cast iron syphons; on arrival at the city, the water is conveyed by leaden pipes through the streets into the houses. The pipes are enveloped in hollowed marble conduits. The length of the aqueduct is 5 miles. The Genoese have however wisely availed themselves of the progress of time, and have made such alterations as to render this aqueduct almost entirely modern. The celebrated syphon bridge called the Ponte dell' Areate, is a portion which crosses the valley of the torrent Geivato, and carries the channel from the hill of Molassina to that of Pino. The horizontal distance between the two extremities of the syphon is about 2,193 feet 6 inches, and its lowest part is placed at a difference of level from the upper reservoirs of 164 feet; the difference between the two reservoirs being 24 feet 6 inches. The diameter of the pipes is nearly $14\frac{2}{3}$ inches, with a thickness of three quarters of an inch. The total length of this aqueduct is nearly fifteen miles from the source at Schiena d'Asina to the city, and its construction dates about the year 1782.

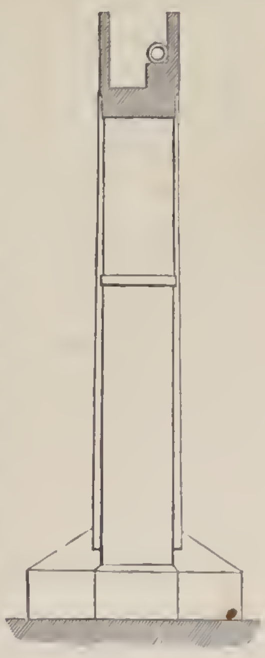


Fig. 12.

The aqueduct is often the only testimony to the military occupation by the Romans of the territory on their frontiers: the traveller will find such ruins at Apulum (Weissenberg), and Drusus is claimed as the builder of the conduit which once supplied Ulpia Trajana (Koloswar). Diocletian is named as the builder of the aqueduct from Salonæ to Spalatum, five miles in length, built of squared stone in regular courses, with a single range of arches. The finest remains in Germany of subjects of this class are at Treves, where the piers of an arcade are still standing, and are accompanied by portions of the channel: and similar vestiges are to be found at Augusta Rauracorum (Basle Augst), and the Colonia Agrippina (Cologne).

Commencing the list of ancient aqueducts in France, the most northerly will be found to be that of Metz, supposed to have been built by order of Drusus, in the reign of Tiberius. The principal source of this aqueduct was above Gorze, and thence the channel, following the hills in a serpentine line with great detours, passed not far from the village of Jouy aux Arches, six miles on the road from Nancy to Metz. Its total length from the mill of Gorze to its destination, although only about nine miles and a half in a straight line, was nearly fourteen miles, with a fall of nearly 73 feet, or about $\frac{1}{1000}$. This is not uniform, as the slope varies according to the character of the country. The portion in arcades which passed the Moselle near Jouy, in a single tier of 118 arches, each about 17 feet 10 inches span, on piers 14 feet deep by 4 feet 5 inches wide (Plate III, Fig. 7), must have been about 3583 feet long. As only seventeen arches remain on the side next Jouy, and five on the opposite bank of the Moselle, it is difficult to say what was the height of the arches above the river: the road passes under one about 60 feet high, built of stone-like bricks 3 and 4 inches high; the imposts are of white marble. At both extremities of the bridge were reservoirs for delivery; the receiving cistern is circular, probably because the aqueduct here makes a right angle. The remarkable features in these two reservoirs are the centre basins, intended, without doubt, to prevent the sediment therein from entering the aqueduct, and for this purpose a step, level with the bed of the channel, formed the basin twelve inches deep. The channel divides upon the bridge into two branches, for which, amongst several reasons assigned, the best appears to be the desire to check in some degree the velocity of the current, so as to allow the sediment to be more quickly deposited in the basins.

In the neighbourhood of Lyons traces have been found of three Roman aqueducts (Delorme, *Recherches sur les Aqueducs de Lyons*, 12mo, Lyons, 1760); the first, which was constructed by the troops of Mark Antony, drew its water from the Mont d'Or, by means of two branches which embraced that group of hills; but the water thus furnished not being sufficient, a second was built to take water from the Loire, near Feurs; and the third, presently to be described, was made by Claudius, who was born at Lyons, to supply the highest portion of the hill on which the palace of the emperors was situated: all these aqueducts, built in the same age, are of similar construction. Afterwards a fourth was made along the Rhone, whose water was taken near Montluel and Miribel; this last seems to have been intended for the supply of the lower town, and it is doubtful if it were a Roman work.

The aqueduct of Mont Pila (Pl. III, Figs. 6 & 9), commonly known as the aqueduct of Lyons, obtained its supply at the foot of Mont Pila and from several branches which meet it in its course: it is more than thirty-nine miles in length, on account of its circuit, the direct distance being only thirty; and if to the larger amount be added the different feeders, the total will be about forty-five miles. The aqueduct is carried in the vallies by fourteen bridges, excepting in three cases by sonterazici, one between S. Foy and the suburb called Fourvieres, where the valley is 1,700 feet wide; another from S. Foy to Boan, or Bannan, where the dip is 3,458 feet wide and 325 feet deep; and the third, from Chaponest to Soucieux, where the valley is 2,600 feet across by 217 feet deep; five tiers of arches would hardly have sufficed to carry the canal or channel across it. In the course of this article the same mode will be mentioned, but only describing those aqueducts of more recent construction. The difference of level between the source and outlet of this aqueduct is 360 feet, which, for thirty-nine miles, gives a fall of 1 in 572, or about 1 foot 9 inches in 1000 feet.

For the canals or channels of the aqueducts, either below ground or piercing the hills, the Romans (according to Delorme's inference drawn from this aqueduct), made a trench five feet wide by ten feet deep, following one uniform slope of 1 in 600, and in this trench they built the aqueduct, placing at the bottom a mass of masonry, one foot in thickness, on which were raised two walls, each eighteen inches thick, five feet high, and two feet apart, forming the channel, and surmounted by a semicircular vault one foot thick, ordinarily covered by two feet of earth; the inside of the channel being coated with six inches of cement on the bottom and on the sides. The junction of the sides with the bottom was rounded in the angle. The walls were constructed with small stone rubble, from three to six inches thick, bedded in mortar in such a manner as to leave no space between the stones. The use of larger stone than six-inch rubble was avoided, because walls of small stones, well grouted, were found to form a mass more solid than one built with large blocks: bricks do not appear to have entered into these constructions. The Romans preferred coarse gravelly sand for this sort of masonry to fine sand, which is scarcely proper but for plastering; and when obliged to use it, they took care to mix it with pulverised brick, as in the aqueduct of Nismes; the same course was adopted with the coarser sand, and lime from the best stone was frequently used.

The cement employed for the plastering of aqueducts was composed of portions of brick, the size of peas, for the first coat, and much smaller for the last. In plastering the bottom the pieces of brick were as large as nuts and eggs; the mixture was made with fresh lime, without any other ingredient. The walls of the channels out of the ground are from 22 to 24 inches thick; the external faces are of reticulated masonry, each lozenge of which is $3\frac{1}{2}$ inches square, without any courses

of bricks. The covering of the vault of the aqueduct in the open air was slightly rounded to let the rain-water run off, yet sufficiently flat to allow of walking upon it to the reservoirs and into the aqueduct, which were entered by iron trap-doors, two feet square, worked into their vaults. The subterranean portions had similar entrances upon square wells, raised two or three feet above the ground; two such still remain between Mornant and S. Laurent d'Agny. To regulate the entrance of the water into the aqueduct, a flap (*vanne*, floodgate), or paddle (*porte à coulisse*, sluice-gate), was placed at each supply, to let no more enter than the quantity desired: this was about $22\frac{1}{2}$ inches.

The aqueduct on the ground—here that of Mont Pila only is spoken of—was supported upon solid masonry, six feet in thickness, while the highest above ground did not exceed six or seven feet; but when it was higher, arches were constructed, and piers for the arches, as the elevation increased. Upon this depended the width of the arcades, the size of the piers, and their height: for example, if the headway of the arch gave 18 feet, its diameter was 12 feet, the pier 12 feet by 6 on its face, and the foundation 3 or 4 feet deep, according to the nature of the ground, with three sets-off of six inches each. As the upper portion in which the canal or channel is placed is only six feet thick, a chamfered set-off of ten inches has been worked on each face, which reduces the pier and arch to the thickness required. All these portions of the aqueduct were of similar construction, in small rubble work, laid in courses, and bedded in mortar, and the external faces in reticulated masonry, which was bonded at every four feet in height by two courses of large bricks or tiles, twenty-two inches square and two inches thick. The small ashlering at the angles, which had not sufficient bond with the lozenge work, has contributed to the decay of the erection, as it has been seized for private buildings. Such piers could only be constructed by caissons four feet high, tightened by two rows of keys or bands, like moulds. The arches, semicircular, are formed by voussoirs of ashlering, about three inches thick, with a row of large bricks as a hood, upon the key of which runs a double course of bricks throughout the length of the aqueduct, without forming any projection: on these bricks the drain of the channel is based. The masonry does not appear to have been well executed, for there are many indications of repairs, and the piers of the bridge on the valley of Chaponest, which were originally made with transverse discharging arches, needed to be filled in solidly before the bridge was finished.

The Baunan souterazici only differs from that of Chaponest, about to be described, in having reservoirs 19 feet 6 inches long by 6 feet 6 inches wide, with openings for twelve pipes, because it was laid in the deepest of the three valleys; the perpendicular height of the descending limb being 282 feet. The third souterazici was much less important, and does not require special notice. The reservoir on the Soucieu hill was placed on strong piers, and was internally 14 feet long by 4 feet 6 inches wide, and 4 feet 9 inches high to the springing of the semicircular vault, with walls 2 feet 3 inches thick of rubble, faced with dressed and coursed stone, and two ranges of wrought iron ties to resist the pressure of the water. The vault is pierced in the middle by an opening, two feet square, which may be judged to be for a free supply of air (though Delorme supposes it was intended for an entrance), because had it been simply a door, it would have been closed with an iron gate, as in the length of the aqueduct. At nine inches above the bottom of the reservoir, its wall, next the valley, was pierced by nine oval openings, 12 inches high by 10 inches wide, and 7 inches apart: through these apertures the water left the delivery reservoir by as many leaden pipes, $8\frac{3}{4}$ inches diameter and $1\frac{1}{12}$ inches thick, which, descending into the valley, were laid at first upon ramping arches, and afterwards upon solid masonry, the fall being regulated to the top of the arcade, upon which they crossed the bottom of the valley. (Plate III, Fig. 6.) The pipes continued of the same diameter for one-half the descent, or about 81 feet; they then divided each into two smaller pipes of 6 inches diameter each, which completed the descending limb of the tube, continued over the bridge in the bottom of the valley, and then remonnted to an equal height, where they again became nine pipes as before, and so connected the two reservoirs. The pipes in the level part were laid upon carefully constructed walls, with large stones at the elbows, and were covered with earth, well rammed down, to resist the cold, and in some degree the pressure; they were also tied down to the sleeper walls. A set of vent pipes was brought from the lowest part of the descending tubes above the level of the upper reservoir to secure the discharge of air. The perpendicular height of the upper limb of the tube was 164 feet; that of the lower limb was 142 feet 2 inches, and the whole width of the valley 2,600 feet. The reservoirs, which took the water from the pipes on the opposite side differed from those whence the water came, inasmuch as the openings to receive the pipes were placed about three feet above the drain, so that the reservoir, and consequently the aqueduct, could hold two feet in depth of water, while in the delivery reservoir it might be three or four feet deep, on account of the resistance of the air to its entry into the tubes, or rather on account of the pressure of the atmosphere in the receiving cistern.

In the valley near Saintes (Mediolanum Santonum), exist some slight remains of an aqueduct; and Caylus (*Recueil d'Antiquités, etc.*, 4to., Paris, 1752-67) described other ruins near Luynes, in Touraine, about 900 feet long, in sixty-two arches then in tolerable preservation, each arch being 10 feet 5 inches span, on piers 4 feet wide at the ground, but 3 feet at the springing, the tallest pier being about 28 feet high; all the work was executed in small rubble, and the specus or forma no longer existed. There are also remains of an arcade over the valley of Gargallon, close to the road leading from Forum Julii (Fréjus) to Antibes, which must have been of considerable length. The arches, which are entire, are about 56 feet high, and they are strutted, by means of buttresses, against the extremely violent gusts of wind, which occasionally sweep along the valley (Cresy).

The aqueduct of Nismes is probably the most ancient of the remains of such erections executed by the Romans beyond the Campagna. The boldness of its erection, and the beauty of its proportions, combined with the picturesque nature of its position, render this one of the most impressive series of arcades, which will come within the scope of this notice. The formation of the fabric may be attributed, according to the authorities who give the highest antiquity, to M. Vips. Agrippa. This aqueduct, whose development is about twenty-one miles from the gates of Nismes, forms, in its course of 135,305 feet, a horse-shoe shape; for it obtained the water from the sources of the Eure and Aivan, situated to the eastward of, and below, the town of Uzès; while the Pont du Gard is the middle, and the fountain at Nismes the termination of the aqueduct. The Pont du Gard, at that portion which covers the deep valley of the river Gardon or Gard, amongst the hills between Vers and S. Bonnet, is composed of three tiers of semicircular arcades, springing from imposts upon the piers (Pl. II, Figs. 13, 17, 18). The lowest story has six arches; the next range has eleven, and they are both of the same height of 66 feet, and the arches in both stories are 63 feet 10 inches span, except over the river, where they are 80 feet span, springing from a lower level than that of the imposts of the side arches. The length at the level of the first story is 561 feet 9 inches; at that of the second, 882 feet $11\frac{1}{2}$ inches, which last figures give very nearly the dimensions of the top of the aqueduct between the two extremities, which have been broken away or destroyed. The uppermost tier, 28 feet high, consists of thirty-five arches, each about 16 feet 9 inches span; but no correspondence with the lower ranges is preserved. As the two hills forming the valley are not of equal elevation (that on the left bank being much lower than the level of the aqueduct, while the opposite

one is much higher), the channel was sustained on one side by a long range of arches, similar to those of the higher story, and on the other it was, of course, engaged in the side of the hills; the top of the conduit being about 157 feet 6 inches above low water in the river. The width of the piers in the first tier is 21 feet 6 inches; of the second, 15 feet; and of the third, 12 feet; this projection on each side, added to that of the cornice, forms foot paths 4 feet 3 inches wide, and two feet wide, by which the valley was crossed at either level. This Pont du Gard is entirely constructed of squared freestone, with its face coarsely pointed by the masons, from the foundations up to the third course above the cymatium, which crowns the piers of the highest tier, no rubble work having been used in filling up the haunches and piers of the two lower ranges. The spandrel filling and the upper portion of the third story were the only parts of the masonry which were worked to a smooth face; all the masonry was laid dry without any cement, and owes its stability to the mass of each block and the precision of the beds and joints. The corbels, on which the scaffolding and centres were erected were never cut away; this sensible precaution has been met with in several other ancient examples.

The conduit, or rather channel, is the only part which was not in cut stone; it is constructed in ordinary masonry on the two faces of the bridge and aqueduct, and in rough rubble for the interior; this rubble-work, in which cement was not spared, formed a mass absolutely impermeable to infiltration. The inside face of the walls and the bottom, which was worked hollow to a segment of a circle for its transverse section, Fig. 13, were covered with a coat of cement, about 1$\frac{7}{8}$ inches thick, made of lime, fine sand, and almost pulverized brick, and still possessing a tenacity and consistency equal to the hardest stones; no wearing away, no alteration, being as yet found in it. This first layer of cement was covered with another coat of very fine mortar, at most $\frac{1}{26}$ of an inch thick, and of a deep dark red colour, leaving a waterway 4 feet 2 inches wide.

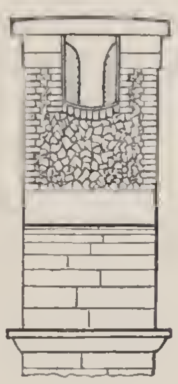


Fig. 13.

The courses are in general two feet in height: the key-stone of the large arch is 5 feet 3 inches, and that of the others 5 feet, deep: those of the arches of the upper story are 2 feet 7 inches in depth. The lower arches are formed of four separate rings, those of the range above of three, and those of the upper range, of single rings or courses of voussoirs. Each soffit exhibits three distinct arches not tied or bonded together.

The aqueduct is constructed with the same care throughout its length, the only difference being, that in the exposed parts, it was finished with slabs of stone, 14 inches thick; while in the subterranean portion it was covered by a semicircular vault, of rough rubble work, about 1 foot 11$\frac{3}{4}$ inches thick, which gave to this part an additional height of 2 feet 2 inches inside, because the vault always sprang from 5 feet 3 inches above the bed of the channel. A considerable petrifaction or concretion was found formed on the exposed side of the innermost antique coating of cement, and it had gained a thickness of more than 10$\frac{3}{4}$ inches at the height of 3 feet 3$\frac{1}{2}$ inches from the bottom; from its immediate diminution, it results that the height of the water was regulated by the abundance in its feeders, and that its most usual height in the canal was 3 feet 3$\frac{1}{2}$ inches; it rarely rose to 4 feet 7 inches, because here very slight traces of sediment are found. The fall of the channel was about 1 in 2,500.

It is supposed that the aqueduct was broken up by the barbarians about A.D. 406; and upon this conjecture the water would have been running for about four centuries. At the commencement of the eighteenth century, according to RONDELET and others, but in reality of the seventeenth, the Duke de Rohan, to facilitate the passage of his artillery, caused all the piers of the arches in the middle row, on the upper side, to be cut away for one third of their thickness, about 10 feet high; setting aside the barbarism of the deed, it must be confessed that it was done with some conscience, because the equilibrium and construction of the masonry were preserved; as it was considered that this mutilation was ruinous to the bridge, repairs were made in 1700, under the architect Daviler. In 1745 a carriage way was built against the Roman work, at the level of the floor of the middle story, and other repairs of the structure were executed to ensure its stability under Pitot (Pl. 2, Fig. 18).

In considering Paris and its environs or rather dependencies, it appears that the first existing modern French aqueduct was executed under Philip Augustus, between 1180 and 1223, to convey a supply of water from S. Gervais and Belleville. Henry IV, besides adding watermills to the Seine, in 1606 proposed bringing water by an aqueduct from Arcueil, which owes its origin to the Emperor Julian, who, after building a palace on the ground afterwards occupied by the Sorbonne and the Hôtel de Cluny, about the year 360, constructed an aqueduct, which was more than 48,000 feet long, to supply this palace, and the thermæ appended to it, with water from the villages of Louans, Montjean, Chilli, Vuissous, and other places in their vicinity. This aqueduct was destroyed by the Normans, and it had so remained for more than eight centuries. After the death of Henry IV, the new aqueduct was steadily continued and the water from Arcueil is said to have reached Paris in 1634, under the direction of the architect Jacques de Brosse, and from that time till the year 1780, numberless plans were submitted and put into execution by Louis XIII and XIV to increase the supply. Although the aqueduct has been partly reconstructed, yet improvements remain to be made, especially at the sources. Fragments of the ancient construction still exist, contiguous to the modern work, which is about 45,937 feet 6 inches long. At present the water called d'Arcueil (because it is brought by an aqueduct constructed at the extremity of the village of that name), comes from a place called the Grand Carré of Rungis. This great reservoir, receives all the springs which are brought thither by the different water-courses. It is a square plot of ground about seven and a-half acres in extent, encompassed by a vaulted gallery. In this gallery is a channel, which receives all the water, and conducts it into a reservoir, situated at one of the angles of the before-mentioned site, and then into a vaulted subterranean channel. Many loopholes (*barbacanes*) have been worked in the walls of this channel at intervals between the first reservoir (that of Rungis) and the aqueduct-bridge of Arcueil. These openings receive the land water, and also the contents of many water-courses, which have been made since the construction of the aqueduct; the part of it from Rungis to the bridge is 22,020 feet long, with a fall of 42 feet $\frac{1}{6}$ inch. The bridge is 1,250 feet long and 11 feet 9 inches broad, strengthened at every 40 feet by buttresses, between which are nine arches, each 25 feet 7 inches span; the greatest height is 72 feet, of admirable construction in squared stone. At the head of the aqueduct-bridge is a reservoir in which is a *carré*, receiving all the water; it is here guaged, thus giving a means of knowing the increase or loss which may have occurred between Rungis and Arcueil. The water, leaving this *carré*, crosses the valley of Arcueil on the aqueduct-bridge, and afterwards runs below ground to a waterhouse near the Observatory. This part of the aqueduct (Plate II, Fig. 20) is 25,980 feet long, with a fall of 11 feet 6$\frac{1}{4}$ inches. In the length last mentioned there are twenty-seven reservoirs, having staircases to allow of workmen descending. On arriving at the observatory the water is divided, one part going to the Luxembourg, Rue d'Enfer, the other portion to the half-moon of the Chartreux. At these places it is subdivided to the public fountains and to private concessions.

Two sections are given (Plate II). Fig. 19 shews the old construction, with the channel and a *banquette* or raised way on each side of it, on which to step along; but as these were found to be very inconvenient, a *banquette*, on one side only and much larger, was formed in the new construction as shown in Fig. 21.

At Maintenon, the valley of the river Eure is crossed by the imposing ruins of the aqueduct commenced in 1680 by Vauban and Lahire at the mandate of Louis XIV, to convey water from the Eure at Pont Gouin to Versailles. The war of 1688 interrupted the labour, and it was never resumed. The source was seventy-one miles from the Cour de Marbre at the Palace, with a fall of 1 in 2,933. It was intended that the Maintenon aqueduct-bridge should be nearly three miles and a quarter long, in three tiers of arcades (Pl. III, Fig. 12, and Pl. II, Fig. 9), 234 feet high; altogether containing 685 arches; but it was partly pulled down to build the villa of Crécy for Mdme. de Pompadour, and the present remains consist of forty-seven arches, each 83 feet high and 42 feet in span. This project, far from ever being revived, has been altogether cast into oblivion, and, though unfinished, cost no less than £880,000. The minutest details are given with drawings by RONDELET. Another system for the supply of Versailles and its waterworks was subsequently adopted; which consisted in using about 70 miles of catch-water drains over 37,500 acres, running into 25 reservoirs; a conduit 21 miles long, partly subterranean; and an arcaded bridge at Buc (Pl. II, Fig. 22), about 1,965 feet long and 133 feet high, where it crosses the Bièvre. It consists of two rows of arches: the upper are nineteen in number; the lower range carries a bridge 13 feet 2 inches wide, over which the road crosses the valley, and is continued on a terrace of earth, so that the lower arches are completely buried. The length is 1,345 feet, and the height 42 feet 8 inches. The thickness of the piers is 13 feet 10 inches. There are no buttresses, but their place is supplied by giving considerable slope to the sides. The masonry of the piers is in a kind of mill-stone, strengthened by quoins of squared stone. This, and the operations for the same purpose at Rannequin, which necessitated the erection in 1682 of the aqueduct of Marly, are presumed to be still used. This last aqueduct is 2,113 feet long; consisting of a row of arches 25 feet 6 inches span, with piers of the same width, but 19 feet 2 inches thick below, and 6 feet 6 inches above. The greatest height is 82 feet.

Under the Roman dominion, Arles was plentifully supplied with spring water conveyed to it from the Alpine chain, in aqueducts of masonry many miles long (Pl. II, Fig. 4); the modern town is now destitute of this important commodity.

The aqueduct of Carpentras is 2,560 feet long, and is composed of thirty-three semi-circular arches, 38 feet 4 inches span, and 12 lesser arches of 25 feet 7 inches span, all in one range; below the level of which is the segmental arch, 76 feet 9 inches span, on which it crosses the Auzon. The width below is 17 feet, and 7 feet 3 inches above: the greatest height is 82 feet (Pl. III, Fig. 5).

One of the most magnificent aqueducts existing in France is that of Montpellier, begun in 1742 and completed by the architect Pitot in 1752. The source is at the spring of S. Clement; the channel runs about 42,000 feet to the Place de Peyrou, where it terminates in a very handsome castellum; this forms the termination of a construction 3,215 feet long, of which about 2,300 feet is in an arcade 92 feet high, of two tiers, the bottom being in 70 arches, each arch 27 feet 8 inches span, with piers 12 feet 3 inches wide (Plate III, Fig. 11). The arcade of the upper tier is so arranged as to show three arches between the centres of the lower piers, each arch being 9 feet in span, with piers 4 feet wide. The aqueduct is constructed entirely of squared stone, and the castellum, in the form of a circular temple, over the distributing reservoir, is highly praised. The conduit is about $12\frac{1}{2}$ feet wide and $10\frac{1}{2}$ deep internally (Fig. 14), the fall being uniformly [illegible] or nearly 1 in 35.

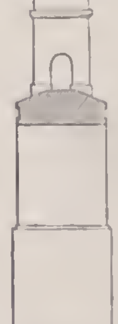


Fig. 14.

The town of Marseilles has however carried into execution, under M. de Montricher, a still more wonderful work, one not exceeded in importance by any such undertaking of modern times. The source of supply is from the Durance, near Pertuis, a distance of nearly ninety-eight miles, of which about twelve miles and three-quarters are tunnelled; and the remainder of the distance required 237 aqueducts, and 537 culverts. The great work, however, is the arcade in three tiers, executed in 1846, of squared stone, with a rusticated or rough scabbled face, over the valley of Roquefaveur, where the width is at least 1312 feet; the greatest height of the arches is 282 feet; the mean height 272 feet, without reckoning the foundations, which reached an additional average depth of 31 feet 6 inches (Pl. III, Fig. 2). The lower tier is about 111 feet 10 inches high, taking an average to the top of the string-course, and the middle range is 124 feet 8 inches. The piers of those two lower ranges are 69 feet 9 inches apart from centre to centre, and the span of the arches is about 50 feet. The illustration will show that there is a difference in these openings, the lower piers being wider than the upper ones. There is about 8 feet 3 inches between the bottom of the keystones and the floor of the tier above, of which 4 feet 3 inches may be given to the string-course. The haunches of the arches are cased by means of a semicircular arch, upon the top of which a passage is constructed through the piers by means of arched openings, each 3 feet 4 inches wide by 6 feet $7\frac{1}{2}$ inches high at the different stages. The third story is 35 feet 6 inches high to the top of the aqueduct, and is so divided as to show three arches between the centres of the lower piers.

About three miles on the road from Tarragona to Lérida, there exists on the right hand a Roman aqueduct, in which a range of two arcades rises to a height of 96 feet (Pl. II, Fig. 11). There are eleven arches in the lower story, 20 feet span, on piers 11 feet 8 inches wide by 12 feet deep; and twenty-seven arches in the upper range, 21 feet span, on piers 10 feet 8 inches wide by 9 feet deep, forming a bridge 700 feet long: it is remarkable for the slope given to the upper piers. The water runs, partly underground, nearly twenty miles from the Pont d'Armentara; and the aqueduct is called *le milagros*, a general name for such wonderful structures, the *puente de Ferreras*, and by the vulgar *del Diablo*. It was ruined by the Moors, and so remained upwards of a thousand years, until repaired by the Archbishop Joaquin de Santiyan de Valdivielso, who died in 1783, leaving funds to complete the work, which was done by Señor Armañac. It was again destroyed by Marshal Suchet, who broke it down near the Olivo; but these injuries have likewise been repaired, and it still supplies the town.

As the steep banked rivers below Segovia are difficult of access, and their water not very wholesome, the pure stream of the Rio Frio was brought by the Romans, on an aqueduct attributed to Trajan, from the Sierra Fonfria, commencing about nine miles from the city, near a house on the road to S. Ildefonso. Beginning thus, near S. Gabriel, it runs 216 feet to the first angle, then 462 feet to the second at la Concepcion, then 925 feet to the third at S. Francisco, and then 937 feet to the city wall. Passing along one side of the Plaza del Azoquejo, and as far as the small square opposite the church of S. Sebastian, the water is thence distributed by subterranean channels to the houses. The aqueduct-bridge, consisting of 109 arches, was respected by the Goths, but broken down in 1071 by the Moors of Toledo, who sacked Segovia and destroyed thirty-five arches. It remained in ruins until August 26, 1483, when Isabella II employed a monk of the Parral convent, named Juan Escovedo, to restore it, who had the good taste to imitate the model before him. The new work is intermixed with the old, and occurs chiefly near the angle of la Concepcion and S. Francisco. The total length is about 2,530 feet, the greatest height of the bridge is 104 feet, and when necessary two ranges of arcades were employed; the arches in the upper range were 11 feet 8 inches span, on piers 4 feet 6 inches wide by 6 feet deep: the arches in the lower range were 13 feet 8 inches span, on piers 11 feet 6 inches deep. The illustration (Plate I, Fig.

13) obligingly furnished by Mr. Waring, will give some idea of the magnificence of this aqueduct, which is of squared stone laid without cement, and altogether fifteen miles in length; still supplying water, at the height of the city itself.

Toledo, built on a lofty rock, was badly supplied with water; whereupon the Romans spanned the defile with a gigantic viaduct and aqueduct, which ran from the Puerto de Yevenes about twenty-one miles. Its greatest height is 102 feet, at Los Siete Cantos, and the lower arches are 11 feet 8 inches span, the upper arches being 15 feet 8 inches span; it is built of granite, laid without cement or mortar; and, like other similar Roman works, unites simplicity, proportion, solidity, and utility, in one general effect of grandeur.

The great aqueduct of Merida, however, is considered to be one of the grandest remains of classic antiquity. Ten arches are nearly perfect, and thirty-seven piers remain in place. Some of these piers are 90 feet high, and arched in three tiers (Pl. III, Fig. 8), with a level platform running between each, and made of granite worked *en bossage*, and of brick, which is principally used for the stringcourses. This was only one of the many Roman aqueducts which poured rivers into Merida; another, crossing the Madrid road, although it has only three arches left standing, puts to shame a modern attempt at an aqueduct built by the Maestro Esquivel, under Philip II; which conveys water from El Borbollon, a spring which rises about six miles from Merida, near the village Truxillanos.

The aqueduct of Evora, forty miles long, is a Roman work of grey limestone, and of brick; there is a peculiarity about this work deserving particular attention, viz., that the arches are divided into bays, with stouter piers forming buttresses in both the longitudinal and transverse directions of the bridge; this consists of twenty-five arches, each 13 feet 6 inches span, on piers 4 feet 6 inches wide by 9 feet thick, of which it has been noticed that the width was one-third of the span, and the united length of the four sides of the pier was equal to twice the span. The arches were 50 feet high under the keystone. The castellum, which contained the distributing reservoir, was a beautiful circular edifice 12 feet 6 inches in diameter outside the walls, and around it were eight Ionic three-quarter columns with their entablature, supporting a second story, with flat pilasters, and surmounted by a hemispherical dome, all executed in brickwork covered with cement. The spaces between the columns on the lower floor were decorated with semicircular niches, having striated heads; and the spaces between the pilasters in the upper floor were left open for ventilation. This is still nearly perfect, as is the rest of the aqueduct, which continues to supply the modern town.

At Italica (Sevilla Vedra),—the birth-place of Trajan, Hadrian, and Theodosius,—traces exist of the reservoir of the aqueduct constructed by Hadrian; the other works are not now visible. The Caños de Carmona are Roman arches repaired by the Moors, forming part of the well supplied conduit, which even runs at present, although unknown to the majority of the inhabitants of Seville.

Between Liria and Chelva, or Chelves, may be seen an aqueduct built about the year 1500; and some remains of a Moorish aqueduct exist at Chestalgar, near Chelves, whose Rambla de los Arcos takes its name from a fine Roman aqueduct partly in ruins (Pl. II, Fig. 8). These successors to the dominion of Spain also executed the small aqueducts at Castellon de la Roma, and under the Rambla de la Viuda, near Grenada: both these were chiefly undertaken for the purpose of irrigation. The extreme height of the latter is about 70 feet, on arches about 8 feet 9 inches span. The Moors perhaps introduced the system of *souterazici* into Spain; at least that at Castellon de la Plana, which passes under the Rambla de la Viuda, is attributed to them: a similar work is in use at Puerto Real, near Cadiz, constructed in 1776; and there is another modern one at Talavera la Reyna, besides one which supplies the fountain called La Carolina, at Madrid.

The fountains at Pampeluna are well supplied from a noble aqueduct, which was built in a style of Roman solidity, by Ventura Rodriguez, about 1783, the water being brought from the hills of Subiga, nine miles distant; one portion, 2,309 feet in length, contains ninety-seven arches of 35 feet span, and 65 feet high.

The aqueduct which leads the springs from the neighbourhood of Bellas, a distance of twelve miles, to Lisbon, traverses a valley of extraordinary depth, by means of a bridge 2,600 feet long; the centre arch is 229 feet high to the under-side of the key-stone, and 98 feet 4 inches span; the shape of the arch being that of an ellipsis divided, and standing on its minor axis (Pl. III, Fig. 3). There are altogether thirty-two arches, on piers 23 feet by 16 feet 6 inches. The water flows through a channel about 8 feet wide, divided by an upright wall; and on each side are parapets and footways for the purposes of examination and repairs. This is often cited as a work of the Romans; but in fact it was erected by Manoel da Moya, employed by John V, who commenced it in the year 1713, and finished it in 1732. The material is a kind of white marble.

AMERICA.

The former inhabitants of Peru, Chili, and other parts of South America, as well as the ancient Mexicans, constructed many and extensive works (conduits) for the supply of their towns and cities with water, and also for the encouragement of agriculture. The channels were often of great magnitude; for besides many mentioned as being fifty miles in length, Viracocha, the seventh Inca of Peru, is stated to have made one twelve feet in depth, and three hundred and sixty miles long, through the province of Rucana; and another, somewhat similar, traverses the whole division of Cuntisuya, in a course of four hundred and fifty miles. No arches are mentioned in these constructions, for the line was made through the hills; the channel being made of hewn stone cemented together, and earth rammed down over it so tightly as to prevent any escape through accidental holes. Many of these works consisted of two conduits,—the larger was for general use, the smaller to supply the inhabitants and fields while the other was being cleansed. Such were those of Churubusco, still to be seen, according to Humboldt, and of Chapoltepec. It is known that the latter, which carried two or three rows of pipes made of trees hollowed, was built by Montezuma. Iztaclapa, Zacatecas, and Palenque, had their aqueducts; and the ruins of Tezcuco still show the remains of a fine one, in a sufficient state of preservation for general use.—Towers, *Illustrations of the Croton Aqueduct*, 4to., New York, 1843.

The engineers of the United States consider that the Croton aqueduct (formed in order to supply the city of New York), is one of the greatest and most important works in the world, on account of the boldness of the plan, as well as for the admirable manner of its execution. It undoubtedly deserves very high commendation, and is the only great aqueduct in North America; the cities of the United States being chiefly supplied through iron mains. This aqueduct was designed by Major Douglass, under whose direction the preparations for its execution were made; but in consequence of some dissensions the completion of the work was intrusted to Mr. John B. Jervis, previously engaged in the execution of State canals; his principal assistant was Mr. Horatio Allen.

The water of the Croton river was raised forty feet, by the construction of a dam which caused the stream to form a lake of 400 acres; this is the collecting reservoir of the aqueduct. At first it was proposed to use an open trapezium-shaped canal, but as the water might become impregnated in its course, and a considerable quantity be lost by sinking and evaporation, as well as be exposed to the wading of cattle, to bathing, and to being filled up with earth and snow washed in, and might freeze out in winter, it therefore became necessary to cover it. As a wooden roof to the canal did not appear impenetrable to frost

and heat, it was at last resolved to arch the whole, notwithstanding the great expense. The channel, when in cuttings or in embankments, was built of granite or of gneiss masonry. The following is a general description of its form; the side walls, of brick, are sloping, and 4 feet in height; it is 7 feet 5 inches wide at top, and 6 feet 9 inches wide at the bottom, where it joins a brick segmental invert, having a versed sine of 9 inches. The arch is semicircular, either of brick or stone, as considered necessary. When tunnelled in the rock, the sloping sides and invert were retained, whilst the top was formed by the solid rock; and when tunnelling in the earth was required, the side walls were made segmental, instead of sloping, to resist the lateral pressure.

The total length of the aqueduct from its head to the distribution of the water is about forty-five miles, nearly twenty-eight miles of which have a regular fall of 1·1088 feet per mile, *i. e.*, nearly $\frac{1}{4575}$. The varieties of fall to suit particular circumstances are given by SCHRAMKE (*Description of the New York Aqueduct*, 8vo, New York, 1846, p. 26), and TOWERS (above mentioned), whose works may be consulted for all the detail of execution. Ventilators as *lumina* were erected at distances of every third mile, while two others, as *putei*, were placed between each pair of shafts. Twenty-two are made of white marble, the rest, eleven in number, are of gneiss. At suitable points, waste weirs are put, to draw out the water when required, these are seven in the whole line, and they serve likewise for ventilation. The receiving reservoir contains 150,000,000 gallons; it is divided into two portions, for the purpose of inspection and repairs.

To cross the Manhattan valley, an aqueduct bridge, 105 feet high, and 4,180 feet long, would have been required; this would have preserved 3 feet of head pressure for the conduit water, but at an expense of (1,200,000 dollars) £240,000, while the passage by four pipes of 36 inches each, was calculated to cost one-fifth of that amount; it was therefore adopted. For the same reason it seemed desirable to carry the conduit water over the Haerlem river in a *souterazici* with iron pipes, but it was proposed to let them pass in the centre over an arch 120 feet wide and 60 feet high. This was an object of popular disgust, and being compelled by the legislature either to carry it below the bottom of the river, or on a bridge (Pl. III, Fig. 4), the latter course was adopted, although exceeding the tube system by, in cost (200,000 dollars) £40,000. With this arrangement the water crosses the bridge in pipes, with a depression of 12 feet. The bridge is about thirty-three miles from the Croton dam, and crosses a stream whose tidewater occupies a width of 620 feet. There are fifteen arches, eight of which are 80 feet wide each, and 100 feet above flood tide, with piers 14 feet wide, placed in the water way; and upon the shores are seven arches of 50 feet span each, the piers being 7 feet wide; three of the large piers are thickened to 20 feet, to resist thrust, if any arch should fail. A thirty-six inch pipe being put down temporarily, the aqueduct was opened on 4th July 1842. The actual cost amounted to £1,715,000, including the purchase of land required, extinction of water rights and some unfinished works, being within 5 per cent. of the estimate made by the engineer Mr. Jervis; to this is added £360,000, being the cost for the distributing pipes. The money being borrowed, the total expense will be £2,500,000.

It only remains to add, that notice has not been taken of a few unimportant aqueducts, such as those of Tusculum and Volci (CRESY) in Italy; Luynes, Vienne, Coutances, and Néris, in France, etc.; because it seemed unnecessary on the present occasion to do more than place before the reader a general notion of each great work, in connexion with the history of the system.

It has frequently been mentioned as matter of surprise, that some of the aqueducts above described should in modern times have been built in preference to the now ordinary method of the pipe system. On consideration of the merits of the ancient plan, it will be found that although nearly two thousand years have elapsed, some of the erections have incessantly fulfilled their purpose; and if one estimate were made of the cost of construction and repair, in stone or brick, after the Roman manner, and another upon any system of tubes capable of delivering the same quantity of water, their liability to obstruction, to bursting, and to loosen at the joints, their wear and tear, including loss by age and by decomposition, with the generally necessary expense of steam power, the balance would be found infinitely in favour of the method described in the preceding pages, without taking into consideration, that good water loses its quality in metal tubes, while even inferior water is improved while running in a brick or stone channel; besides the above, there are all the inconveniences produced by inequality of pressure in the pipe system, the deleterious effects of the metals employed, and the necessity of taking up whole lengths of mains laid under the solid pavement of our streets, which are rendered impassable during the works; such an inconvenience the Romans wisely avoided, and continued to prefer the system of raised aqueducts even to that of pipes in vaults (patented by JOHN WILLIAMS, *Historical Account of Subways in the British Metropolis*, 8vo., Lond., 1828). The only chance of accident would be the leakage produced by the settlement of a divison of the arcade, and this would instantaneously discover itself. In Central America the conduits were provided double, as was the case at Metz; and the Roman legislation decided that the aqueduct should be unincumbered for fifteen feet on each side in the country, and for five feet in towns.

MR. BURNELL has already made the following just observations, that—"As for the comparison of works of art, the moderns do but make a small figure, when we take into account the great superiority of their means of mechanical execution. With the exception of the Marseilles and Caserta aqueducts, of late no constructions of this kind can be said to rival the works of the Romans in all the magnificence of their details. Even at the present day, the student who would wish to examine the problems connected with the conducting of large streams, could not find better examples or better subjects for examination than the Roman aqueducts. For we may safely assert, that if we examine such works merely from an artistical point of view, we are immeasurably beneath our predecessors in the taste with which we have designed them. Considering them as objects of scientific investigation, we are far from having derived any important benefit from the advancement of the physico-mathematical sciences which has taken place since the revival of learning."

Translated, with additions, by J. W. PAPWORTH, from the MS. of SERVAAS DE JONG, (*Amsterdam*, 1852.)

The following works may be further consulted:—ANDRÉOSSI, *Constantinople, etc.*, Paris, 1828; THE ARCHITECT JOURNAL, for 1850; BERBRUGGER, *Algérie Historique, etc.*, fol., Paris, 1843 (which contains illustrations of several aqueducts); BURGESS, *Topography, etc., of Rome*, 8vo., Lond., 1831; CANINA, *Architectura Ant. Romana*, Rome, 1834; CASSIO, *Corso dell' Acque*, 4to., Rome, 1756; FABRETTI, *De Aquis, etc. Veteris Romæ*, 4to., Roma, 1680; FRONTINUS, *De Aquæductibus Urbis Romæ Commentarius*, by RONDELET, Paris, 1820; GENIEYS, *Essai sur les Moyens de Conduire, etc., les Eaux*, 4to., Paris, 1829; GUYS, *Voyage Littéraire de la Grèce*, 8vo., Paris, 1776; MURRAY'S *Handbooks for Spain, Italy, etc.*; POCOCKE, *A Description of the East*, fol., London, 1743-5; POLENI, *De Aquæductibus, etc.* (Frontinus), 4to., Patav., 1722; WIEBEKING, *Theor. pract. buerg. Baukunde*, 4to., Munich, 1821-7; WIEBEKING, *Analyse Descriptive*, Munich, 1838.

AQUEDUCT

PLATE 1

Fig 1 ANTIOCH

2 ILLAMUS

3 ILLAMUS.

4. ILLAMUS

5. ANTIOCH

6 CÆSAREA

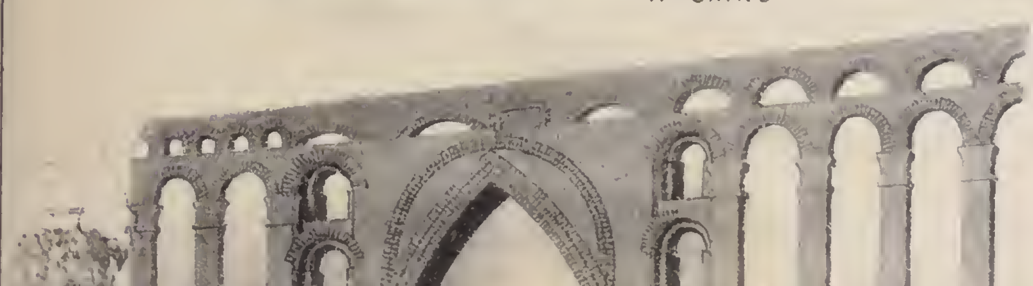
8 MYTILENE

7 ANTIOCH

9. CONSTANTINOPLE

10 ASPENDUS.

11 CAIRO

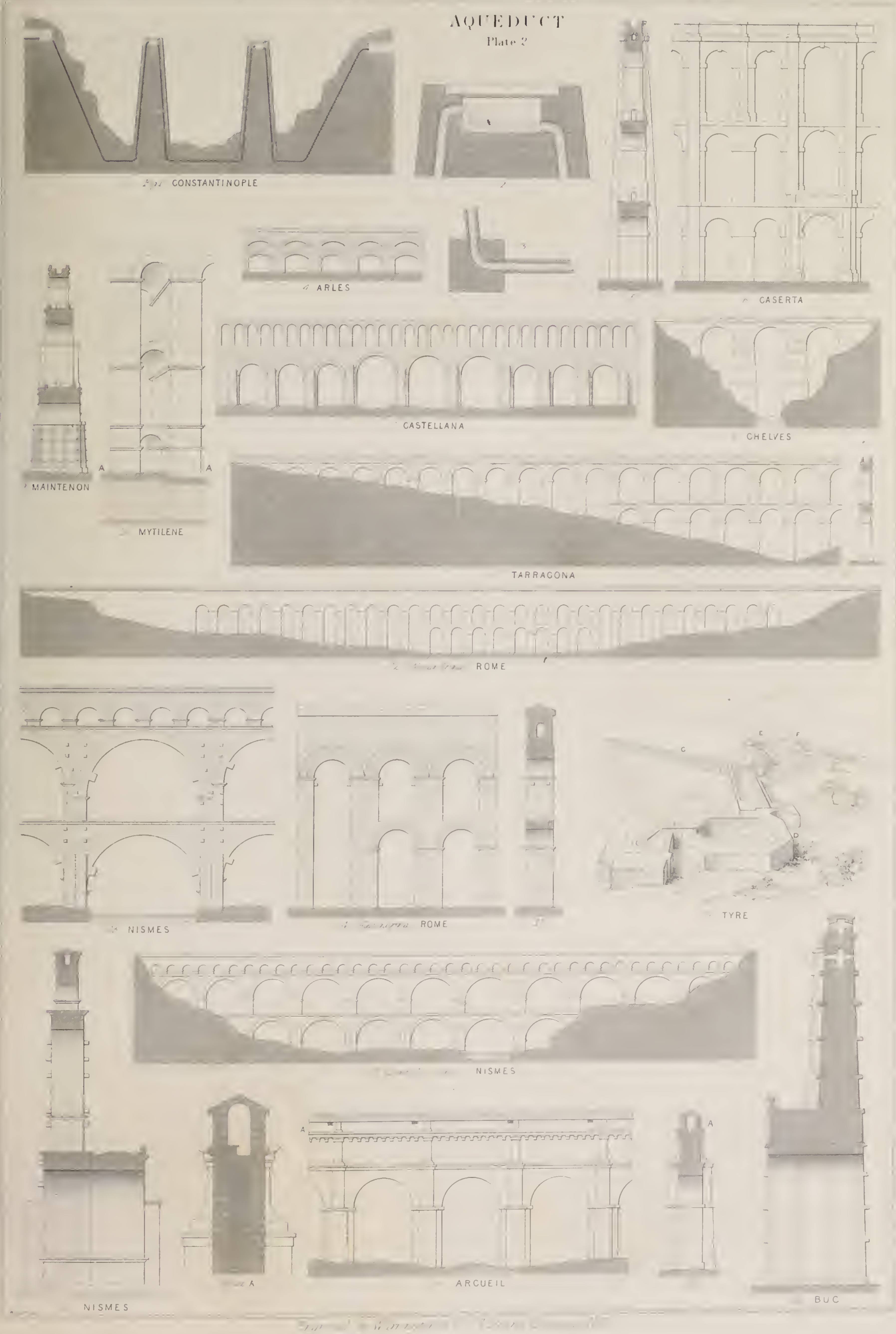


12 BISCARI

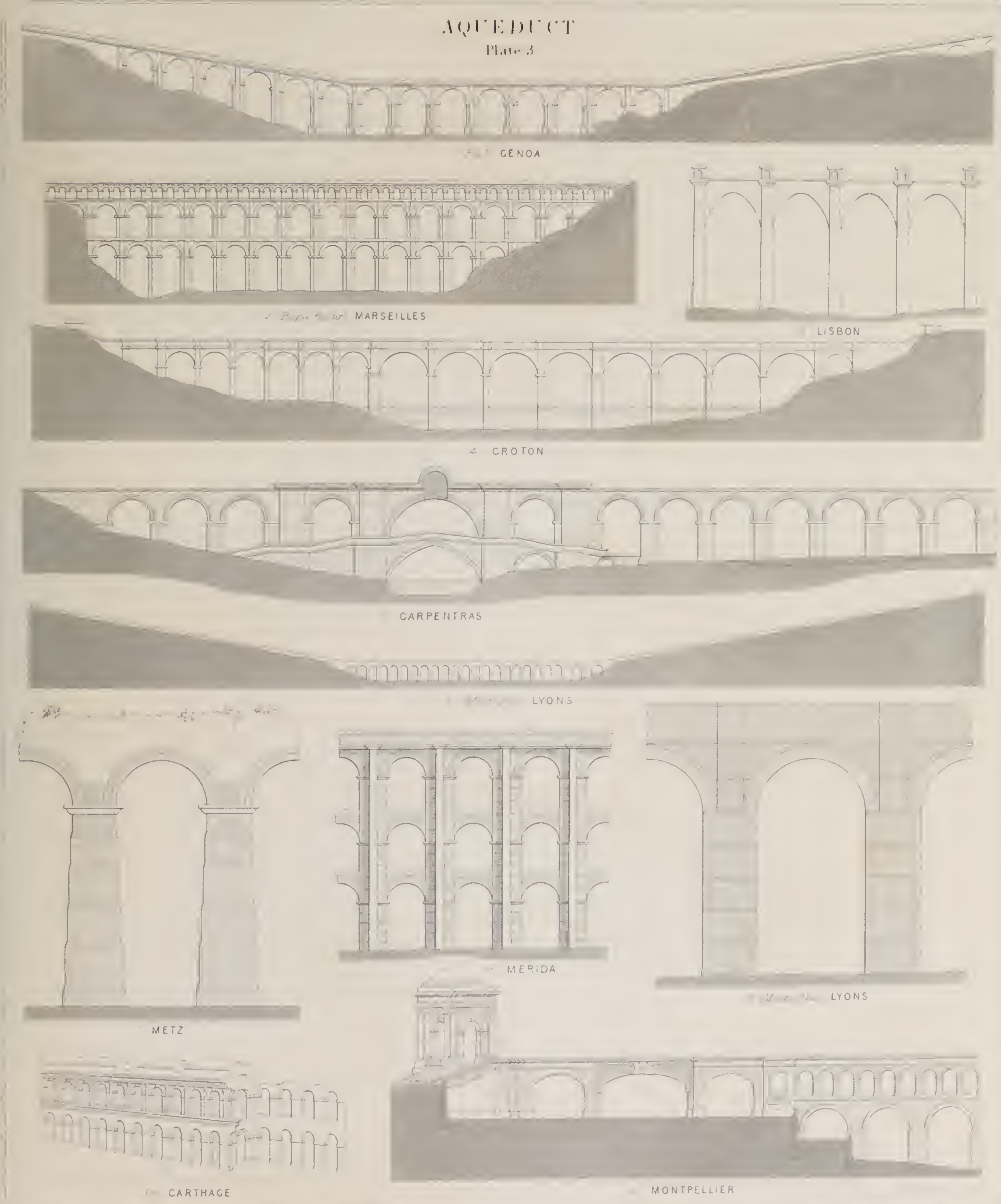
13 SEGOVIA

P. C. Auld, lith.

Printed by Hullmandel & Walton Augt 1st 18..


AQUEDUCT
Plate 2
CONSTANTINOPLE
ARLES
CASERTA
MAINTENON
MYTILENE
CASTELLANA
CHELVES
TARRAGONA
ROME
NISMES
ROME
TYRE
NISMES
NISMES
A
ARCUEIL
BUC

AQUEDUCT
Plate 3



ARCADE.

Fig 1.

Termination at the Church of the
MADONNA DELLA GUARDIA _ BOLOGNA.

Fig 2.

Entrance called
PORTA DI SARAGOZZA _ BOLOGNA

Fig 3.

Portion showing the general design of
ARCADE _ BOLOGNA

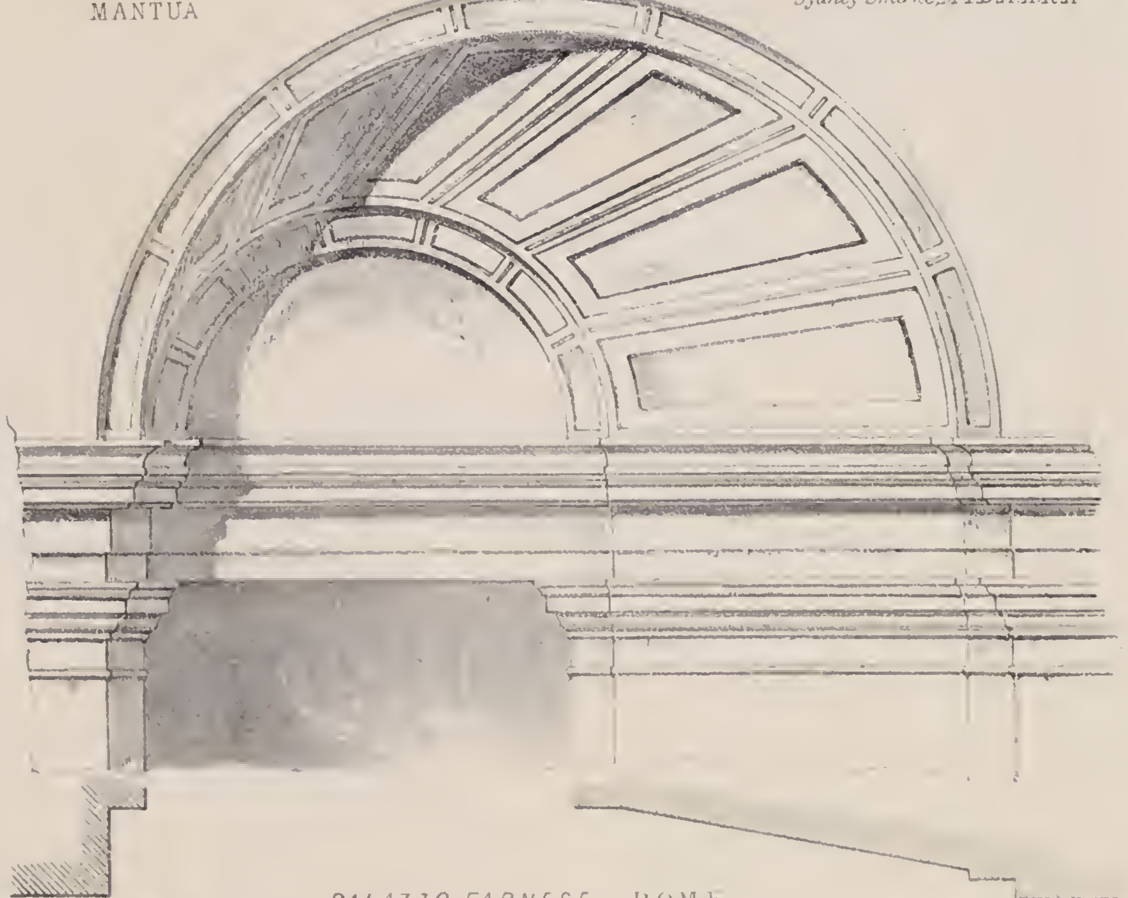
Edward I'Anson, Junr M I B A

Lithographed by Messrs Day & Son April 3rd 1856

ARCH.

PALAZZO DEL TÈ
MANTUA

Sydney Smirke, M.I.B.A. A.R.A.



A. J. Green M.I.B.A.

PALAZZO FARNESE _ ROME
UNDER AMBULATORY

PALAZZO FARNESE _ ROME
ENTRANCE TO STAIRCASE

A. J. Green M.I.B.A.

BALUSTRADE

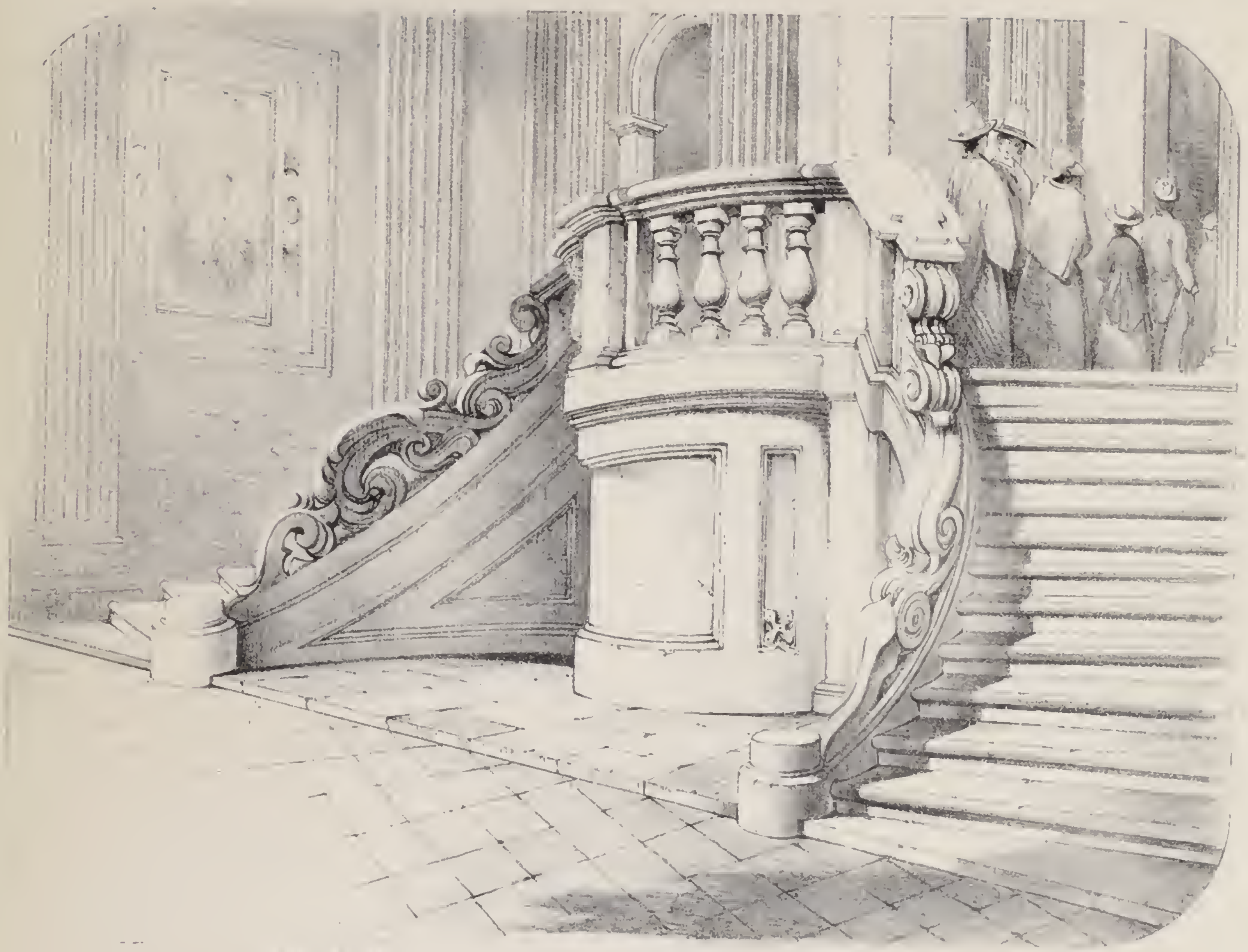


Fig 1 id NAPLES

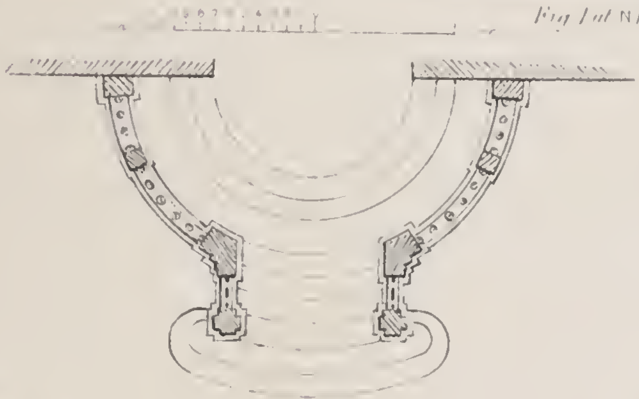


Fig 2 S. Francisco NAPLES

Fig 3 SPEDALE GENERALE - NAPLES

BATHS AND WASHHOUSES.

Baths (Ancient). In the early stages of civilization there is no doubt that the only form of bathing used was the simple plunge into a river, or clear pool. In severe weather this would be too cold for the sick and infirm; and as society advanced in the arts of life, the improvements in constructing pottery or metal vessels no doubt suggested to these persons the use of warm water; and as luxury generally increases as the means of indulgence are discovered, it is probable the healthy in cold weather also availed themselves of the invention. As early as Homer's days, it is evident, from the speech of Alcinöus to Ulysses (*Odyssey* viii, 249) the warm baths, λοέτρα τε θερμὰ, were considered effeminate, and as late as those of Aristophanes, in the memorable contest between "Reason" and "Quibble" (as the δίκαιος λόγος and ἄδικος λόγος may be translated, *Nubes*, 879), it is evident that feeling lingered long in the minds of the Greeks. As population grew denser it was more difficult to preserve the decencies of life, and separate bath-rooms were used; and the economy and convenience of uniting single buildings into large public establishments gave origin to those noble piles, the principal ornaments of cities of the Roman world.

Lavers (כיור) of brass among the Jews (Exodus xxxviii, 8), are noticed, but neither in the Scripture nor the Apocrypha, are separate establishments mentioned. The Egyptians were forbidden (Diodorus 1, 72) to bathe while in mourning; but Sir Gardner Wilkinson confesses there is but little knowledge of their baths: he gives (*Manners and Customs of the Ancient Egyptians*, vol. iii, 389) an engraving from a tomb at Thebes, representing a lady kneeling in a shallow vessel, while her attendants pour water on her, and seem to be rubbing her arms and shoulders. In the classic authors we have numerous and copious allusions to the subject, which have excited the greatest attention and closest controversy.

Confining the investigations as much as possible to the buildings and apparatus, an attempt will be first made to give a short sketch of the etymology of the terms used by the ancients, and what is known of the history of these establishments; afterwards to endeavour to elucidate at greater length their architectural and engineering features.

Baths were called by the Greeks ἀσάμινθος, βαλανεῖον, ἔμβασις, λοετρόν, λουτρόν, πύελος, and πύρια or πυριατήριον. Πλύνος has another meaning, to be explained presently.

Ἀσάμινθος, probably from ἄσις, mud, dirt, because the bath removes it, is a word frequently used by Homer. When Ulysses and Diomede return from the night expedition (*Iliad* x, 574), they first bathe in the sea, and next in the ἀσάμινθος ἐΰξεστας, "polished baths," they then are anointed with rich oil. When Ulysses bathes in Circe's palace (*Od.* x, 359 *et seq.*) one of her attendants "brought water, and kindled fire, and heated much water on a great tripod, but when the water bubbled in the shining brass, sitting in the ἀσάμινθον, she poured from the great tripod, sweetly mixing [the hot and cold water] and bathed my head and my shoulders, that from me she might take away the mind-wasting labour, but when I was washed I was anointed with fat oil." It is probable this vessel was something like the Roman "labrum" in which the bathers sate and had water poured on them from different vessels. Athenæus (1 *pag.* 24, *Ed. Casaub.*) alluding to this passage of Homer, calls the ἀσάμινθος ἐμβάσις. This last is a common word for a shoe, and would lead to the notion that the vessel was of long form—in fact a sort of slipper-bath. Julius Pollux (*Onomas*, 10, 64, 65, *Ed. Hemsterhuis*:) in a much corrupted passage, seems to infer that ἀσάμινθος is the same as λέβης; but he says in the next sentence that in "the Heroes" of Cratinus, ἀσάμινθος signifies a chest, and that some suppose it to be a sort of cup, κιβωτὸν νοοῦσιν, ἔνιοι δὲ ἔκπωμα. The same author, treating of cups (*Onomas*. lib. vi, 97, 99) considers the ἀσάμινθον given to Menelaus (*Odyss.* iv, 128) to be a species of χύλιξ, but this seems quite begging the question. Nothing in the context points to cups more than to any other vessel. He also cites Cratinus (*Chirones*) Ἐξ ἀσαμίνθου κύλικος λείβων: but as the play is lost there is no context to guide one in so short a passage.

Βαλανεῖον, "derived," says the Etymologicon Magnum (*sub voce*) "as ιατρεῖον, from ἰατρός, seems to have been the name of the bath-room rather than of the bath itself, (see *Equites*, 1055, cited further on) and is stated on the authority of Suidas (*sub voce*) to be derived from βάλανος, an acorn, because the baths were heated by burning the cups, etc., of the acorns, the fruit itself being eaten in those days as food. Others have derived it partly from a passage in S. Augustine (*Confessions*, cap. 12) from βαλλειν, "quia pellat anxietatem animi:" this seems a far-fetched reason, and as Philander (see his notes to the folio Elzevir Vitruvius, p. 95) says "cui sententia refragatur orthographia." Be its derivation what it may, it is no doubt the etymology of the Roman terms "Balineum," "Balineæ," contracted to "Balinum," "Balneæ." The other Roman word "Thermæ" is derived from the Greek adjective for "warm" (*sc.*) baths, as a glance will show.

Ἔμβασις has already been mentioned.

Λοετρόν, and λουτρόν, are of course directly derived from λοέω, the Homeric form of λούω, to wash. Some critics have considered λουτρόν to signify a warm bath, and the ἀσάμινθος to signify a cold bath, but Vitruvius (lib. v. cap. ii.) says distinctly "frigida lavatio quam Græci 'λουτρόν' vocitant," and that which much strengthens his testimony, Homer (*Iliad*, xviii, 489) speaks of "λοετρῶν Ὠκεανοῖο." The Ἡράκλεια λουτρά were warm baths. There is a tradition that they were natural warm baths shown to Hercules by Pallas (see the Scholiast on the before-cited passage of the *Nubes*, 1033.)

Πύελος, this Hen. Stephens derives from πύος or πυρὸς, a vessel made for the fire. The Scholiast, on Aristophanes *Equites* 1055, says πυέλους τὰς ἐμβάσεις, the same word which Athenæus considered equivalent to the ἀσάμινθος of Homer. The Scholiast goes on to describe it as "a hollow vessel, πύελος γὰρ ὄρυγμα, where people are washed," and Julius Pollux (vii. 166-169) seems to consider it the same.

This author also speaks of the last sort of bath, πυρία, as described by Herodotus, and πυριάματα as described by Philistus. Of the latter author there are no remains: the former describes the πυρία thus (*Melpomene* 74). He states the Scythians set up three sticks and cover them with cloth like a tent; they place a quantity of red-hot stones under this covering, and taking some handfuls of the seeds of a species of hemp, they creep in under the covering, and throw the seeds on the red-hot stones, so that a smoke arises thence such as no Greek πυρίη, vapour-bath, could exceed; that they rejoice so in this vapour they shout

aloud; that this is their bath, λουτρὸν, and that they never bathe their bodies in water.

There are thus three sorts of baths described—cold, hot, and vapour. The Lacedæmonians seem to have bathed daily in the Eurotas, however cold the weather might be, and the versatile Alcibiades (*Plut. in vitâ*) seems to have excited their admiration by falling in with this custom. They seem also to have used a dry sweating-bath to a great extent, called from thence "laconicum," and which will be hereafter described.

The other species of bathing seems to have been like that described in the *Odyssey*, the sitting in a large vessel, and having hot or cold water poured on the body by attendants, from vessels called αρύταινα or αρύβαλλος—these are both mentioned by Julius Pollux (vii. 167 and x. 63) but without particular description. From a comparison of two passages in the *Equites*, 1087 and 1090, with a fragment of Athenæus, it appears these vessels were much alike, broader at bottom than at the top, and the αρύβαλλος the larger of the two. It is from this last vessel the sausage-seller sees in a vision the patron goddess of Athens casting tan-liquor upon Cleon.

From a passage in Athenæus, ii. p. 501, it seems that in the middle of the baths for the women, there was an ομφαλὸς, in the form, he says, of a hand-bowl, σκάφιον, which covered the waste pipe, and on which the women sat and chatted to each other.

An error has been committed as to the Πλύνος by some lexicographers: this is clearly the washing trough. Homer gives it this name (*Iliad* xxii, 153) as the vessel by the side of the hot streams of Scamander, where the Trojan damsels washed their linen before the coming of the Greeks. And again (*Odyssey* vi, 86) as the vessels used by Nausicaa and her attendants when they go to the river side to wash their garments, which vessels, says the poet, were always (from year to year) left there, Ενθ' ἤτοι πλυνοὶ ἦσαν ἐπηετανοί.

Washing with nitre and soap is mentioned as early as Jeremiah (ii, 22;) and Susanna (*Apocrypha*, v, 17) is described as taking oil and washing-balls into the garden with her to bathe there. The Greeks used a quantity of these things, as enumerated by Pollux (vii, 37, 38), the principal of which was κονία, lye, and a sort of fuller's-earth, κιμωλία γῆ; all these things were called ῥύμμα, and provided, some say, by the bath keeper. But the very passage cited seems to prove the contrary, for the woman in Aristophanes (*Lysis.* 377) says, "If you happen to have the lye," (εἴ ρύμμα τυγχνεις ἔχων,) "I will give you the bath." The perspiration was scraped off by an instrument like a blunt knife, called a strigil, much as the ostlers scrape the sweat from horses with an iron hoop. Xenophon (*Anab.* 1, 2, 10,) describes some of gold, which he calls στεγγλίδες. After further rubbing with towels the bather was invariably anointed all over the body with scented oils.

Much stress has been laid on a passage in the *Odyssey* (xv, 135,) where Pisistratus and Telemachus are so splendidly entertained by Menelaus, to shew that in that day there were separate bath rooms, but the passage seems to suppose the direct contrary; in fact it is curious how such a mistake could have arisen, as the heroes do not seem to have moved from the hall or dining-room. The words are, "Then indeed they sat down on couches and seats, and a maid-servant bearing a basin (χέρνιβα) poured from a ewer (προχοῳ) "beautiful, golden, upon a silver λέβης, that they might wash," she then places close to them "a smooth table," and then she brings bread and all sorts of food. In the *Equites* (1055) the Sausage-seller tells the Demus that the baths (πυέλους) in the bath house (βαλανείῳ) have been taken away, and the Demus cries out, "Then I shall go unwashed to-morrow." It is clear in this case a separate word is used for the bath and the place which contains it. See also the Etymolog. Mag. as before cited.

The origin of public baths among the Greeks is not clear, but it has been supposed with reason that private baths were first opened to friends at a small fee. That such existed is known from Plutarch (*Vita Demet. Poliorcet.*), where he states that Democles, for a particular reason, would go to none but a private bath; this must have occurred about twenty years before Pyrrhus of Epirus invaded Italy. The success of the experiment among friends probably led to the establishment of public baths.

Athenæus relates (viii, p. 351) that in the town of Phaselis, they were in the habit of charging foreigners double for a bath, and he relates a story of a bath-keeper, who when his attendant attempted to overcharge a stranger, cried out, "Scoundrel, would you make me a Phaselitan for a little farthing," παρὰ χαλκὸν μικορὸ. In Lucian's time (Lexiphan.) the charge was but two oboli, and in the time of the Roman emperors, but a farthing, "quadrante lavari," is mentioned both by Juvenal and Horace.

There is but very scanty information respecting the construction of the Greek baths; Athenæus (lib. viii, 501), however, states that they were covered by a θόλος, or dome, and they were probably, in other respects, much the same as at Pompeii, one of those places which we know Juvenal denounces as a "græcam urbem"; in fact not only did the Roman fashion resemble the Greek, but it is extremely probable that the whole system of bathing among the ancients is yet kept up in all its stages to the present day in Constantinople. The East has long been remarkable for steady adherence to every old habit and custom; and it may now be worth while to enquire what was done in the Roman bath, and how far this is paralleled by the Turkish Hummâm.

Although there is such scanty material for an architectural description of the baths of the early Greek period, there are very minute and circumstantial descriptions of those of the later period, beginning with that of Vitruvius, and proceeding with those of Seneca and Pliny, to the time of Lucian, a range probably of 150 years.

The first-named author, lib. v, cap. 10 and 11, has given rules for the construction of public baths in the Roman way, and of palæstræ, xysti, and baths in the Greek way. Pliny the younger has given some account of his own baths in two of his letters (ii, 17, v, 6). Seneca (ep. 86) gives a very curious description of the old villa and bath of Scipio Africanus. Lucian, in a separate treatise, "Ιππίας ἢ βαλανεῖον," describes some baths just erected by Hippias; these authorities are of course accessible to every one, and well known to the learned; so much only therefore will be extracted as will instruct without fatiguing the reader; the engineer's work will then be described, and it is proposed to conclude with a very brief account of the remains of some of these noble works of antiquity.

Following the description of Greek work it is thought preferable to take the 11th chapter of the 5th book of Vitruvius before the 10th. He commences by saying, he intends to explain the Greek edifices, although they are not in use in Italy. In palæstræ, he says, square or oblong peristyles (courts or cloisters) should be made in circuit the length of two stadia—each stadium is the eighth of a Roman mile, consequently the circuit would be 1,203 ft. 6 in. English, and the court about 300 ft. square. On three sides the colonnades are to be single; these, he says, the Greeks call διαυλοί, but on the south side it is to be of double width with a double row of columns to keep out the dash, "aspergo," of the rain in the windy season. In the three single colonnades are to be species of pavilions (hexedræ) with seats, where philosophers, orators, and others, may sit and dispute. On the side of the double colonnade, in the middle, is to be a very large hexedra for the young men to exercise in, with seats. It is to be one third longer than its breadth; on its right side a "coriceum." (On this word there is much dispute, it will be treated of under its proper head, Coriceum; it may suffice to express an opinion that it is a place for playing with the pilum, or ball sewed with leather. Under the strict seclusion the Greek women were kept, it is very unlikely the girls, κοῦραι, would be admitted in the very midst of the young men.) Next to this, the "conisterium," or

place where the wrestlers were sprinkled with dust, that their adversary might not have a slippery hold. Next the "conisterium," in the turn of the colonnade "versurâ porticus", was the cold bath, which, says one author, the Greeks call λουτρὸν: on the left of the ephebæum (or young men's hexedra), the eleothesium, or anointing chamber of the young men, and next to that the cold elæothesium; from this passage we would suppose there was a difference between the ointments used after hot and cold bathing. From thence, one author says, there is a way into the propnigeum [literally choke-chamber] at the turn of the court; this was probably the stokery. Much difference of opinion has been expressed as to this word; it is difficult to conceive why a hypocaust or præfurnium should be supposed to be more "choking" than the hot "laconicum," but on looking a little closer into Vitruvius and the meaning he gives his words, in the account of the water machine (lib. x, cap. 13), it will be found that he employs a sort of check valve, or damper, in the form of an inverted funnel, and calls it pnigeus. The ETYM. MAGNUM, *Edit. Princeps, sub voce*, gives this curious passage "πνιγεύς, among the comic writers a furnace, and it is also part of an hydraulic machine, and signifies the bridle; it comes from πνίγω, the second aorist is ἔπνιγον, from this is πνῖγος, which signifies burning, or heat, and the word πνιγεύς, which signifies a baking pan, and also the bridle for beasts yoked to a carriage." It appears highly probable that the πνιγεὺς was the *damper* to the furnaces, to *bridle* or increase the draft. If this be correct, no doubt "propnigeum" was the stokery. Next this, within the region of the frigidarium (not the frigida lavatio), is the concamerata sudatio, or vaulted sweating room; at one end of this is to be the laconicum, which will be treated of hereafter, opposite to this is the hot bath. Here is the sum of his description of the Greek ξυστός.

The Roman baths are described in cap. x. VITRUVIUS directs first, choose a site as warm as possible, averse from the north and north-east, because the hot and tepid baths should have their light from the south-west (occidente hyberno: literally, "winter sunset"); if there are any difficulties as to the site, then from the south, as the time for bathing is from noon to evening. Then it is to be contrived that the hot baths of the men and women should be contiguous, that the hot water vessels should easily be used in common by both. Let there be three brazen vessels (our author directs) joined together (componenda), one hot, another tepid, and so placed that as much water shall flow from the tepid into the hot vessel, as hot water shall go out. The like from the cold to the tepid vessel. Let the vaults of the "alveoli" be heated from one common fire; as already intimated; [all this work will be treated upon hereafter.] Let the "suspensuræ" of the cells [hollow floors under which were the furnaces] be thus made: first, let the ground be paved with 18 in. tiles, laid with a fall to the furnace, so that a ball, if thrown in, should not be able to remain, but must run back to the stoke hole, and so that the flame may circulate better under the "suspensuræ;" let pieces of eight inch bricks (laterculis bessalibus) be built so that two feet tiles may be bedded on them. The height of the piers to be two feet, to be built with potter's clay (argilla) and hair, and the two-foot tiles bedded thereon, to carry the pavement. It would be better if the structure were arched, but if there be framed tie beams "CONTIGNATIONES" (which see; and also TRABS, TIGNUM, &c.) let "SIGNINUM OPUS" (flooring composed of a concrete, made of pounded tiles and lime, something like Messrs. Fox and Barrett's principle) be placed under. Let iron rods or bows (arcus) be made, let them be suspended to the trusses, by crooked irons, as closely as they can. Let the rods or bows be so disposed that the tiles can lie and be carried in pairs, and so the whole vaulting be perfect: let the upper part of this chamber be lined with lime and hair; the lower part, which looks to the pavement, to be first trowelled with baked clay and lime, and then let it be polished with fine stuff ("albario," lime without sand, see PHILANDER in *loco*) or stucco ("tectorio," lime with sand). These chambers in the hot baths, if made double, will be the more useful, as the damp of the vapour will not injure the material of the roofing "contignatio," but will pass off between the two chambers.

"The sizes of the baths must be according to the number of bathers. Let them be thus made: the width the same as the length, less one third, exclusive of the 'schola of the labrum' (bath) and of the alveus. The labrum bath should be constructed under a light (window) so that those who stand round should not darken the light by their shadows. It is necessary that the whole of the baths should be spacious, as when the first shall have taken their places, the others looking on should stand properly. The alvei should not be less than six feet wide between the wall and the pluteus, so that the lower step and the seat (pulvinus) should take off thence two feet."

It will be better now to pause and examine this passage.

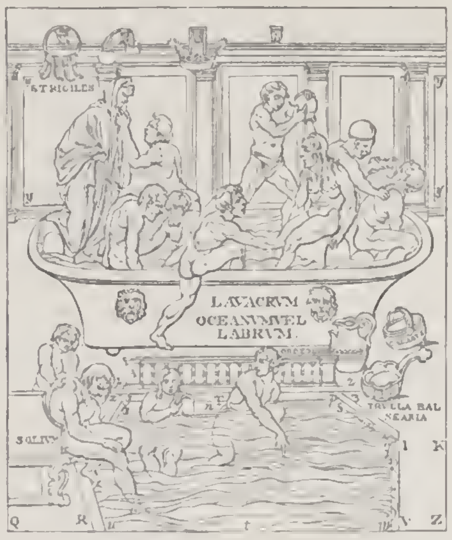


Fig. 1.

That "labrum" is the bath, the πύελος of the age of Aristophanes, has already been explained, and of which there is no sort of doubt. The alveus has generally been considered to be the hollow part of the bath itself; but there seems this difficulty, if a seat and step of two feet are to be taken off six feet, the bath could only be four feet long, and could never have held nine persons at once, as shown in Fig. 1, given by MERCURIALI, *de Re Gymnas. apud Polen.*

Alveus has a great number of significations; from its primary meaning, the belly, it seems to have expressed any long flat hollow vessel—a trough or a tray, a back-gammon board (*duodecim scripta*) the hold of a ship, any trough-like hollow utensil or vessel.

The section of the bath at Pompeii, as given by SIR WM. GELL, is shewn Fig. 1, Plate II. Former writers, and even some later ones, have suggested A as the alveus; while MARINI and those who have followed him consider A to be the labrum, B the upper seat or spaces called scholæ (at Pompeii in the piscina are niches in the scholæ), C the pluteus, and D the solium, or inner seat. Now the labrum, marked E, Fig. 1, seems to have been a large laver, or πύελος, as shown also in Fig. 2, from the baths of Titus; and there seems no reason why the rim of the bath should be called a wall "pluteus." It is not necessary to pursue this criticism further, but to suggest that PLINY, Ep. lv. 6, calls the bath "puteus": if pluteus be considered therefore to be an error of the transcriber for the former word, the meaning of alveus is plain—it is the passage between the wall and the bath. This emendation, however, is thrown out with considerable diffidence.

The description of Vitruvius finishes thus: "Let the laconicum and sweating-baths be joined to the warm-bath, these should be as broad as they are high (measuring) to the lowest curvature (springing) of the hemisphere; let a light be left in the middle of the hemisphere, from which let a brazen shield hang by chains, by whose rise and lowering, the temperature of the sweating may be regulated. It should be made circular (*ad circinum*), that the force of the flame and vapour should pervade equally from the middle by the roundness of the curvature."

These descriptions are given at greater length as the work of the great architect of antiquity: the others will be merely glanced at; that of PLINY (*Epist.* lib. v, 6,) gives a picturesque account of his Tuscan villa, at the foot of the Appenines: of course his bath was private. After describing the different parts of the house, he says: "There is then the winter cubicu-

lum extremely warm, as it is filled with the full sun; attached is the hypocaust, and if the day be cloudy, its emitted vapour supplies the place of the sun. Then the apodyterium receives in its cold cell him relaxed and joyous from the bath. In this is a plunging bath (baptisterium) wide and deep. If you wish to swim at more ease and in warmer water, in the area there is a piscina, and in the next a puteus, if you would again be cleansed (abstergi may be read, rather than astringi) if you dislike the weather. He then states there are "cellæ frigidariæ," cold rooms, a "sphæristerium," or tennis-court over the apodyterium, and then he proceeds with an account of the rest of the villa. A description of his other villa at Laurentinum is given, lib. ii, 17. In the midst of the minute details of this villa is the mention of "cold-baths broad and spacious, on the opposite sides of which are two plunging-baths (baptisteria) in which you may swim if you wish. Next to this the anointing-room, and the hypocaust, and next to the bath the stokery (propnigeon) then a warm-bath, whence the swimmer may look on the sea. Next to this the tennis-court," etc. etc.

A most delightful description is given by SENECA, *Ep.* 86, of his visit to the bath of Scipio Africanus: he contrasts the little plain building belonging to the great hero with the luxurious baths of his day. The letter throws little light on the architecture. The mention of columns and statues would not be unexpected, but our readers will be surprised however to hear of inlaid gems, glass windows, and silver bath-cocks (epistomia) as early as about A.D. 50. The letter will amply repay a perusal, but is too long for these pages.

The description of the baths erected by Hippias, must not however be passed over quite so lightly. It is given by LUCIAN in a tract under that head. He commences by stating how few men there are, and how much they are to be commended, who shine in more than one art or science, and then praises Hippias as one who was at once celebrated as an orator, writer, mathematician, mechanician, musician, and architect. He then enters upon a long relation of the baths erected by him. After describing the difficulties of site and foundation, he says, "a large common hall (οἶκος) receives those who enter, fit for the footmen and servants to wait in; on the left are chambers fitted up for lounging (ἐς τρυφήν). These, he says, are excellently fitted up with plenty of light near the baths, and suitable for the genteeler (εὐδαιμονεστέρων) people [in fact first-class waiting-rooms]. After these, and beneath, are sufficient receptacles for taking off clothes, ἐπαρκεῖς τοῖς ἀποδυομένοις ἀποθέσεις (dressing boxes). A middle hall of great height, superbly lighted, holds three swimming-baths (κολυμβήθρας) of cold water, adorned with Lacænian marble. In this are two antique statues of white marble—Health and Esculapius. Entering thence, a hall, gradually warmer, receives you with a not unpleasant heat, of long form, and arched throughout. Then, on the right, is a hall containing every variety of ointments, having entrances below ornamented with Phrygian marble leading to the palæstra. Then another hall, the most elegant of all, fitted to stand or sit in, to wait a long time or to 'roll oneself about in' (ἐγκυλίσασθαι) of polished Phrygian marble to the very top.

"Within is the hot-bath (θερμὸς) of Nomad-stone. Inside of which is a beautiful hall, full of light, and as it were flowered with purple. In this are three hot-baths (πυέλους).

"There is no need to return by the other halls, but directly by the cold room (or bath) ψυχρὸν, through the gently warm (tepid) bath (ἠρέμα θερμοῦ)"—LUCIAN then goes on to describe, in general terms, the light and beautiful appearance of the building, but on this and his conclusion there is no occasion to dwell.

Some readers might think an apology necessary before the next and last classic authority is introduced. It is from the *Oneirocritica* of ARTEMIDORUS, of Daldis—the Dream-book of the ancients. No Seven Dials catch-penny, with a gaudy frontispiece, pourtraying a gentleman in an intensely blue coat, and a lady in all the colours of the rainbow, extending their palms to an old woman in a red cloak, but a grave serious quarto, in very good Greek, of the age of the Antonines. The passage is, however, very curious, and as it is doubted that it has ever been submitted to the English reader, a portion is here abstracted. "To dream," says the author, "of bathing was formerly not considered to be bad—for they knew nothing of baths, but they washed in ἀσαμίνθοις. In later times it was judged bad to dream of baths, even of seeing them; for men generally bathe after labour, and especially after returning from the wars. But now-a-days the bath is nothing but the introduction to good cheer—ἡ ὁδὸς ἐπὶ τροφήν—and therefore to dream of beautiful and clear baths, and genial warmth, is a sign of wealth and prosperity, it also signifies health to the rich. To dream of bathing in an unusual manner is bad, as to dream of entering the θέρμαι with one's clothes on." He then relates a story of a lute player, who was hissed off the stage after dreaming he was in a bath without water. "It is good," he says, "to dream of bathing in rivers and pure springs, but not to swim—this signifies danger and disease. To dream of the strigils and instruments for cleansing the skin (στεργίδες τε ξύσται καὶ κατομάγεια) signifies servants. He who dreams of losing his strigil will lose a slave." This might be interesting on the other side of the Atlantic. "The oil-flask (λήκυθος) and the strigil-case (ξυστροφύλαξ)," he says, "signify your wife's slave, or a faithful maid-servant."

It appears from the foregoing that in the later times, there were two sorts of bathing, the cold and the warm. This treatise, of course, is of baths, rather than bathing, and it is desirable to describe no more of one than will illustrate the other, and make the treatise intelligible.

The parts of the cold baths seem simply to have been, first, the apodyteria, or dressing rooms. It is singular that VITRUVIUS, with all his minuteness, does not mention this; while LUCIAN calls them ἀποθέσεις, or in common English, drawers, boxes, or literally, "put-away" places. It is possible they were not rooms, but enclosures, like our dressing boxes. At Pompeii, the frigidarium seems to have served as the apodyterium. The clothes were taken, some authors say, by servants, called "capsarii," because they put them in "capsæ" (see the *Digest.* i, 15, 8, where the theft of clothes is made a capital crime); others call them "caprarii," because the garments were hung up on hooks of horn. That this seems an invariable practice we learn from Cicero's speech in defence of M. Cœlius Rufus, charged by the notorious Clodia Quadrantaria (the Lucrezia Borgia of the day) with an attempt at poison. The drug, this female Titus Oates swore, was to have been conveyed in a box by a young man named Licinius, and given to Cœlius in the bath. Cicero shows how unlikely and improbable a story this is, as there was no means of concealment of a box when the parties were undressed, and that if "shod" and dressed "calceati et vestiti," they would not have been admitted. That the dresses were left in the same way on the woman's side is learnt from OVID (*de Arte Amand.* iii, 639).

Next was the plunging, or swimming bath, called λουτρὸν, κολυμβήθρα, βαπτιστήριον, piscina, puteus, natatio, natatorium, &c. At Pompeii this is circular, about 13 feet in diameter and 3 feet deep, with scholæ or vacant spaces, and niches round it. That the Romans used to swim in these, there is the often cited observation of Cicero to his brother Quinctus, where he wishes for a wider piscina that he might not hurt his hands when he flings them out. After this, it is surmised, came the cold anointing chamber, the "clæothesium frigidarium" of VITRUVIUS, and this seems to have completed the cold bathing. They who used the hot baths also commenced by undressing, either in the apodyterium or the frigidarium.

It is not desirable to enter into the different methods of bathing as recommended by the two great doctors of antiquity, Galen and Celsus; suffice it to say, like other doctors, they differ: the first recommends, to commence with the hot air of the laconicum, then the warm bath, then the cold; while the latter recommends, first, the tepidarium, then the caldarium (which in-

cludes the laconicum), then the frigidarium. While in the laconicum, the perspiration was scraped off by the strigil, and a sort of shampooing took place. The anointing is beside the present purpose; those who wish to know more of the unguents of the ancients, should consult that wonderful and amusing collection of all the scraps and *omnium-gatherum* of antiquity, the *Deipnosophists* of Athenæus.

Perhaps most light will be thrown on the subject by a comparison with the modern Turkish bath. As it will be necessary to make some allusion to these before the conclusion of this treatise, the highly graphic description of the celebrated Mr. Michael Angelo Titmarsh is at once extracted. This ingenious gentleman writes from Constantinople, thus:—

"I made the dragoman conduct me to one of the best appointed hummâms in the neighbourhood, and we walked to a house at Tophana, and into a spacious hall lighted from above, and which is the cooling room of the bath [the frigidarium of Vitruvius]. This spacious hall [the οικὸς of Lucian] has a large fountain in the midst, a painted gallery running round it, and many ropes stretched from one gallery to another, with profuse draperies of towels, and blue cloths for the use of the frequenters of the baths. All round the room and the galleries were matted enclosures, fitted with numerous neat beds and cushions for reposing on, where lay a dozen of true believers smoking or sleeping, or in the happy dozing state. I was led up to one of these beds to rather a retired corner, in consideration of my modesty; and to the next bed presently came a dancing dervish, who forthwith began to prepare for the bath.

"When the dancing dervish had taken off his yellow sugar-loaf cap, his gown, shawl, &c., he was arrayed in two large blue cloths [probably περιζωματα] a white one being thrown over his shoulders, and another, in the shape of a turban, plaited neatly round his head. The garments of which he divested himself were folded up in another linen and neatly put by. I beg leave to state I was treated in precisely the same manner as the dancing dervish. [If the αποδυτηρια be considered to be the same as the αποθεσεις of Lucian, the above is an exact description of the ancient bath; if the apodyterium was a separate hall or room, it would certainly have been so described by Vitruvius].

"The reverend gentleman then put on a pair of wooden pattens [soleæ; Spartianus calls one of the chambers in the baths of Caracalla, 'cella solearis'] which elevated him about six inches from the ground, and walked down stairs and paddled across the moist marble floor of the hall, and in at a little door, by the which also Titmarsh entered. But I had none of the professional agility of the dancing dervish; I staggered about very ludicrously upon the high wooden pattens, and should have been down on my nose several times, had not the dragoman and the master of the baths supported me down the stairs and across the hall. Dressed in three large cotton napkins, with a white turban round my head, I thought of Pall Mall, with a sort of despair. I passed the little door; it was closed behind me; I was in the dark; I couldn't speak the language; in a white turban, mon Dieu! what was going to happen.

"The dark room was the tepidarium, a moist, dark, oozing, arched den, with a light faintly streaming from an orifice in the domed ceiling———

"When you get into the sudarium, or hot room [the laconicum and caldarium], your first sensations occur about half a minute after entrance, when you feel that you are choking [see the description of this apartment by Lucian, in the Hippias, given above]. I found myself in that state, seated on a marble slab; the bath man was gone; he had taken away the cotton turban, and shoulder shawl; I saw I was in a narrow room of marble with a vaulted roof, and a fountain of warm and cold water: the atmosphere was in a steam, the choking sensation went off, and I felt a sort of pleasure presently in a soft boiling simmer, which, no doubt, potatoes feel when they are steaming. You are left in this state about ten minutes; it is warm, certainly, but odd and pleasant, and disposes the mind to reverie.

"But let any delicate mind in Baker-street fancy my horror, when, on looking up out of this reverie, I saw a great brown wretch extended before me, only half dressed, standing on pattens, and, exaggerated by them and the steam until he looked like an ogre, grinning in the most horrible way, and waving his arm, on which was a horse-hair glove———

"The grinning man belabours the patient violently with the horse brush. When he has completed the horse-hair part, and you lie expiring under a squirting fountain of warm water, and fancying all is done, he re-appears with a large brass basin, containing a quantity of lather, in the midst of which is something like old Miss Mac-Whirter's wig, that she is so proud of, and that we have all laughed at. Just as you are going to remonstrate, the thing like the wig is dashed into your face and eyes, covered with soap, and for five minutes you are drowned in lather; you can't see, the suds are frothing over your eyeballs; you can't hear, the soap is whizzing in your ears; you can't gasp for breath, Miss Mac-Whirter's wig is down your throat, with half a pailful of suds, in an instant you are all soap; wicked children in former days have jeered you, exclaiming, 'How are you off for soap?' You little knew what saponacity was till you entered a Turkish bath——[The same operation is described by Savary, one of Bonaparte's savans in Egypt; curiously enough, he says, they called the soap *rusma*, evidently a corruption of ῥυμμα, of which mention was made before].

"When the whole operation is concluded, you are led—with what heartfelt joy I need not say—softly back to the cooling-room [this explains the use and name of the ψυχρον, or frigidarium], having been robed in shawls and turbans as before. You are laid gently on the reposing bed; a cool sweet dreamy languor takes possession of the purified frame, and half an hour of such delicious laziness is spent, as is unknown in Europe."

There is no apology needed for quoting at such length this brilliant little description, feeling that it illustrates the subject both of ancient and modern baths so well, and besides (a thing it is hoped ever before one's eyes) it saves space, and the reader's patience.

It is now proposed to turn to what in these times is called the *engineering department*. Like everything else the Romans did, this was carried out in a far more vast and striking manner than would be at first supposed. It is now found difficult, even with best Low-moor plate boilers, and all the appliances of modern science, to keep baths going for one hundred persons. Conceive then what it must have been in the baths of Diocletian, where 1,800 persons were accommodated at once. Let the mind be made up to listen to something out of the way, and be told that all this mass of water was boiled in brick chambers, put together with lime and hair, and lined with tiles bedded in the same; that there are the remains of a set of these chambers, twenty-eight in number, below (or as a ground story), covered with twenty-eight other chambers as a sort of first story, and containing two millions and a quarter cubic feet, or nearly fourteen million gallons, all heated by one furnace forming a basement; that such a building would actually cover more ground than Exeter Cathedral, and would hold as much water as that entire building, transepts included, if filled to within nine feet of the ridge rib of the groining, and that this mass of water was boiled without apparent difficulty; an idea of the Castella of Antoninus can then be imagined, and also some faint idea formed of Roman engineering. What are the dye or print works of the present age to this? The boiler power at the largest foundries or factories, is a plaything to it. This interesting subject will be now entered into at more length.

The furnaces have been carefully described in the above cited passage from Vitruvius, and seem to have been constructed so as to be best adapted for burning wood. The ash is a simple alkaline powder (the κονία of the Greeks, of immense

value to the ancients, as the method of separating soda or potash from chlorine was unknown), a powder which could easily be swept away by a broom, unlike the soot from coals: no fire bars, or bridges were wanting; a simple paved floor with a slight incline to give a draught, was all that was necessary. In fact it was like the bottom of a country oven. But, how simple piers of brick in pottery clay and hair, and simple tiles, and a sort of trowelled concrete floor on this, could bear at once the vast heat of the fire, a weight of water of many tons to the foot, and the expansive power of the boiling fluid, besides the wear and tear of constant flame, is wonderful indeed. However, there are the Roman hypocausts to this day, and the united labours of Piranesi, and of Cameron (*Baths of the Ancients*, fol. London, 1772), have proved to demonstration this is no fable.

Of course these are the suspensuræ of Vitruvius. At Pompeii, instead of 8in. square piers 2ft. high, they are 9in. square and only 1ft. 7in. high. They support strong tiles 15in. square, on these is the *signinum opus*, or Fox and Barrett concrete, and then where they are visible, as in the laconicum, a mosaic pavement is bedded upon it. Every wall and every pavement was perforated by square earthen tubes, Plate II, Fig. 5, fitting into each other, through which the flame and smoke circulated and afforded as much heated surface as possible. See also the detail from the Baths at Augusta Rauracorum, Fig. 1, Plate III. The invention of the suspensuræ has been attributed to the Sybarites; be that as it may, it was evidently new in the time of Seneca. That author (Ep. 90) speaks with wonder of the things discovered in his memory, as window panes made of talc; the *suspensuræ* of the baths; and "tubes impressed within the walls", through which heat might circulate equally above and below; contrivances to cut and polish marble, and to erect porticoes and arches; and lastly, the invention of marks for words, "by which an uttered speech might be seized, and the hand follow the celerity of the tongue." If the good philosopher marvelled so at short hand, what would he have thought of the electric telegraph?

The English antiquary must beware of an error into which too many persons have fallen, namely, that of calling every Roman remain *a Bath*, where a hypocaust has been discovered. Most of those found in this country were intended to warm the dwelling rooms, and supply the want of an Italian climate in houses which strictly followed the Roman model. The small "foculus" or brazier, with which the Romans were accustomed to ward off the little winter they got in their own climate, would have been useless in the rigorous winters of a wooded country, where every stream was ice-locked during the winter months. Fancy the looks of some gay-plumed young Centurion, accustomed to lounge along the Via Sacra, or complaining of the horrid algid cold as soon as a little snow fell on the extreme top of Soracte, when his face had to encounter the north-east winds of the hills of Yorkshire—or still worse of the Grampians. No wonder they gladly resorted to the invention of the Sybarites, and that almost every Roman building in England has its hypocaust, in some form or other.

The laconicum seems to have had the usual hypocaust under the floor, and a false lining round the whole room, behind which the heat circulated, like the gallery flues of a boiler. This false lining was formed in a very curious way, of large square tiles, fixed by metal cramps at each corner. It appears that while the tiles were moist, a sort of plug was thrust through in several places, forcing out the clay like a tube, and forming a kind of short pipe on the back of the tile. Through these the cramps passed, and of course the length of the tube regulated the distance from the wall, and the space for the heat to circulate in. A quantity of pitch was found in the stokeries at Pompeii; whether intended to light the fires, or to give an occasional extra impetus to the flame, is not known.

Now that the laconicum is being treated of, it is preferable to revert to the description of the clypeus or shield, as given by Vitruvius. Much conjecture has been bestowed on this subject, but it seems clear enough. Besides the heat of the hypocaust, a painting in the baths of Titus (Fig. 2), shows that a fire was actually kindled in the laconicum. This seems to have

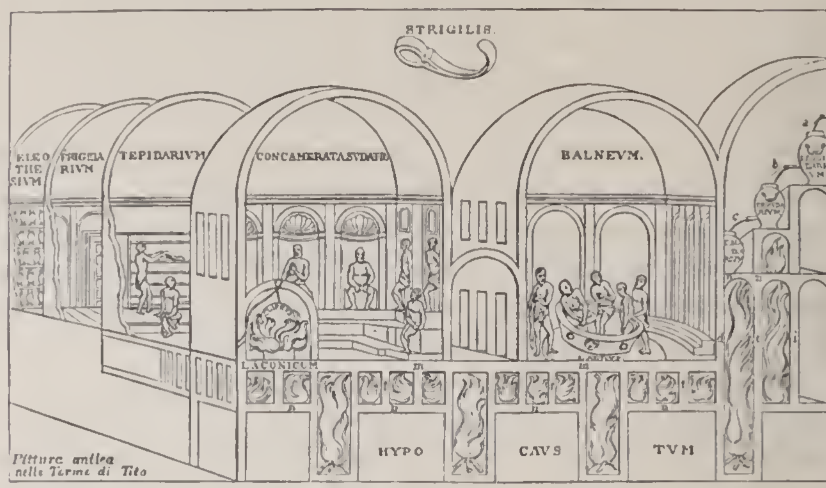


Fig. 2.

been enclosed in some hemispherical metal vessel. Within this is drawn a second, suspended from the first by chains, exactly as described by Vitruvius, and it is easy to see how this second vessel (marked clipeus) could be raised or lowered, and would act as a sort of damper, extinguisher, or large curfew (couvre-feu) on the fire. Probably water was sprinkled on the outer metal vessel to temper the dry heat of the place. Far be it that these individual remarks should be placed against those of more learned authorities, but there is such strong professional bias in favour of a drawing or a diagram, and the matter seems such common sense, that the wonder is, there has been so much discussion about it.

Let the subject of heating the water be now returned to; again reverting to the description of Vitruvius *(vide supra)*. He distinctly describes three vessels joined (componenda) in some way, one boiling, one tepid, and one cold, and so placed in conjunction (collocanda) that as much water should flow from the tepid into the boiling vessel as should be drawn out, and the like from the cold into the tepid. An infinity of labour has been bestowed on this passage, some critics have placed these coppers (ænea) side by side, and supposed that one filled the other by a syphon, some have drawn them as a little above each other, and the water running in an ordinary way from service cocks. Others have placed them one on the top of the other, almost like the old chemical Nooth's apparatus. The second is the way in which they are drawn in the picture, found in the baths of Titus (Fig. 2), and which being a clear diagram ought to have every consideration. But there is this practical dilemma,—if the water passed from one vessel into the other by mere service cocks, how could the middle vessel become tepid? There must have been a connection between it and the boiling vessels, or no heat whatever could pass, and if there was a connection so that the hot water could circulate, the hotter fluid would naturally rise, the highest vessel would contain the boiling water instead of the lowest, and the lowest would be the tepid vessel. With a rapid circulation it might become something more, but certainly could not be the hottest.

If the section of the castella, as given by Piranesi (Plate II, Fig. 2 and 3), be referred to, A will be found to be the main service of water from the great aqueduct; B, a sort of cistern or filter, with probably a grating to catch leaves, etc.; D, a huge open shallow cistern wherein the water was exposed to the sun, and partly heated thereby: this was the roof or top of the upper set of twenty-eight chambers described before, each chamber being 49ft. 6in. by 27ft. 6in, and 30ft. high, all vaulted over, and lined with tiles and opus signinum; F, the hypocaust; GG, the furnace mouths; H, the upper set of chambers; I, the lower set. Fig. 5 shows the pipes, the tubi impressi, in the walls; and Fig. 4, the suspensuræ, all of which have been before described. Now it is clear that D represents the æneum frigidum of Vitruvius, H, the tepid vessel, and I, the boiling vessel. There are many ways in which the supply from one to the other could be regulated. The simplest would be a clack-valve, and a balanced

float. It is not known whether the Romans were acquainted with the ball-cock, but as they knew the bibb-cock or epistomium, this could easily be imagined. Now, as before stated, if there was a constant communication between the two chambers, a circulation would take place and both would boil. The difficulty appears to be easiest explained thus: whatever was the position of the vessels, the steam only, generated by the boiling vessel, was conveyed into the second vessel, and became gradually condensed there by the cold water, just as when a locomotive stands still, the driver turns his waste steam into the water tank, and gets it partially hot, so that steam may be more quickly generated in the tubes, than it would be, were quite cold water injected into them.

A series of plans will be now described of existing Roman baths, beginning at the smallest known example, and proceeding to the magnificent erections of the emperors.

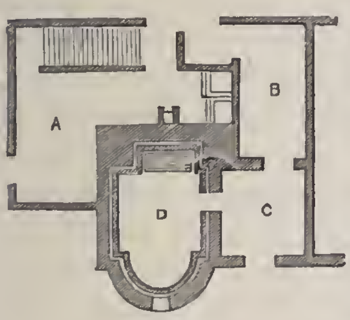


Fig. 3.

Fig. 3 is from a villa on the supposed site of the ancient Stabiæ, a little beyond Pompeii. A, the præfurnium or stokery; B, the frigidarium; C, the tepidarium; and D, the laconicum, with its double walls.

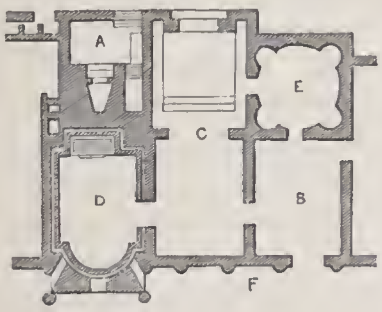


Fig. 4.

Fig. 4 is from the same neighbourhood, but of larger size. A, the præfurnium; B, the frigidarium; C, the tepidarium, of much greater extent; D, the laconicum, of exactly the same plan as the last; but in addition to these, there is E, the piscina, or cold swimming bath: it has niches, or scholæ, like that of the large baths at Pompeii (Plate I, Fig. 2, C); F, part of the atrium of the villa, or colonnade leading to the baths.

The pile of buildings forming the example of baths from Pompeii (Plate I, Fig. 2), fills up the whole space between four avenues, and forms an entire insula, as was usual, and is now so in Italy. The lower portion of the frontage, and perhaps a small mezzanine or room over, were let off as shops. At A, the water service entered, coming from a piscina or cistern, at the other side of the street. 1 appears to have been the stokery; 2, the furnaces themselves; 3, the court for stowing fuel, and for the general use of the engineer; here, as was said before, a quantity of pitch was found; the stairs shown, led, some up to the boiling vessels, others down to the furnaces. The men's baths had three entrances, 4, 5, and 6; the principal was the latter, and led to the waiting-room 7, passing through the open court or atrium 8; the entrance 5 also led to the same court. 7 was surrounded by seats, probably for the servants in waiting, and in it was found the box of the money-taker, and a sword, probably also belonging to this functionary. Passing through the different corridors, as the entrances directed, the bather came to the apodyterium or dressing-room, B. In the corridor marked 4, no less than 500 lamps were found—for what purpose placed there it is impossible to say—the ceiling was decorated with stars, like some gothic chancels. The apodyterium had seats of lava, with foot-stools, and the holes where the pegs were fixed, on which the dresses hung, are plainly visible. A small closet, 9, probably contained the valuables left by the bathers. This room, SIR W. GELL, with great probability, supposed to have been not only the apodyterium, but the frigidarium or cooling-room. This is the more probable, as it leads into the other rooms, just as in the smaller instances. C was no doubt the piscina, frigida natatio, or plunge bath; the niches round were no doubt the scholæ. The bath is 12ft. 10in. in diameter, and 2ft. 9in. deep, entirely of white marble; the supply was a bronze mouth, and at bottom was a small waste to cleanse it out, an overflow waste was placed at the edge. D is the tepidarium, a very handsome vaulted chamber, enriched throughout; the springing of the arch of the ceiling being supported by Telamones, or powerful human figures. In this room were some seats, and a brazier of bronze, showing, that in very cold weather some additional heat was required to render the temperature tolerable. E was the calidarium, containing at one end, as has been shown by the large section (Plate II, Fig. 1), the labrum, and at the other the alveus, puteus, etc. This has already been so fully described that it need not be repeated.

The entrance to the women's baths seems to have been at 10. F appears to have served both as apodyterium and frigidarium: it contains a cold bath, and also accommodation for ten persons to dress or undress. G appears to have been their tepidarium; it is a room about 20ft. square; while H is the caldarium, containing the labrum and a hot bath, 11, close to the furnace like those of the men. The women's baths have suffered much more from the hand of time than those of the men. It would not have served any purpose to enter into the details of the architectural decoration, but only to convey such general ideas of the plans as would illustrate the previous descriptions.

The ground plan of the splendid baths of Diocletian (Plate I, Fig. 1), like all these later edifices, comprehended not only baths, as described by VITRUVIUS, but palæstræ, hexedræ, a stadium, libraries, and even a theatre. This illustration is given as one of the best arranged plans of the kind. The main buildings are situate in the midst of a quadrangle. A, entrance hall (stated by CAMERON, but he does not say on what authority, to be the bath-room of the athletæ); B, the waiting-room, undressing-room or apodyterium; C, the xystus, with margins, that the bystanders might witness the games, and yet be out of the way; D, a large atrium, with a piscina, or swimming-bath in the centre; EE, vestibules leading into FF, tablina, and thence into GG, the cold baths, *frigida lavatio;* HH, the conisterium, or place for anointing and sprinkling with sand; II, ephæbæum, or place for exercise for the younger men; KK, elæothesium; LL, frigidarium; MM, tepidarium; NN, caldarium; OO, laconicum; PP, detached circular buildings, supposed to have been small temples; QQ, libraries; RR, atria to ditto; SS, back entrances, probably to the theatre; TT, rooms attached to the xystus; UU, rooms said to be intended for the athletæ; WW, two peristyles with swimming-baths in the centre; XX, YY, ZZ, detached baths, apodyteria, and elæothesia, said to be for the use of the philosophers, or for other distinguished persons; *aa*, bath keeper's apartments; *bb*, schools; *cc*, the stadium; *dd*, the theatre, *i. e.* the spaces for steps to the seats.

With the advance of Christianity the system of public baths seems to have declined; some have supposed it to be intended to mark the difference between Pagan luxury and Christian simplicity: this can scarcely be agreed to; but it is no doubt true that during the entire mediæval period there is no record of anything like large public bathing establishments in Europe. That bathing, however, was extensively used, and its practice peculiarly respected, is found from numberless instances. The strongest perhaps is the circumstance of the ceremonial of bathing previous to conferring the order of knighthood on those who, during the middle ages, had merited this honoured distinction. The great SELDEN himself, in his *Titles of Honour*, has not been able to unravel the mystery: certain however it is, that the order of the Bath is the second among the exalted ranks of knighthood in our own land. A foreign writer has fancied that the lavatorium attached to monastic buildings had something to do with bathing, but an inspection of the existing cloister would show it was a mere place for washing hands.

The Russians have now, and have had for centuries, a species of laconicum or sweating bath, the heat being produced by scattering water on red hot stones; but as these buildings are mere wooden sheds, it would be useless for the object of the present purpose to dwell on them. The Indians of America have similar baths constructed of wicker and covered with skins. In these they make a sort of sweating bath, not unlike the description given by HERODOTUS of those of the Scythians, with

which nation the North American Indians have many points in common.

There are many public baths in Europe, and some of them splendid buildings; but as bathing seems the last thing thought of by the proprietors, and as the magnificent edifices at Wiesbaden and Carlsruhe, at Bath and Cheltenham, seem decidedly planned for music and promenades, and in some instances even as salons for gamesters, they are also as much beside the purpose as the rude examples above quoted.

The only modern instances of public buildings purely devoted to these purposes are the hummâms of the Orientals. Their similarity to those of the Romans has been already dwelt upon, and much more cannot be added to the graphic description before cited of Mr. M. A. Titmarsh. A plan and section (Plate II, Figs. 6 and 7) is given of one, from the celebrated architect Ramée. A, the divan, waiting-room, or frigidarium, and sometimes serving also as the apodyterium, or dressing-room; B, the tepidarium, or first warm chamber; C, the caldarium, or sweating chamber; and D, the place in which the bather gets the thorough ablution of soap as before described; this room probably answers to the labrum of the ancients. These buildings have another point in common with those of Rome. The bath-rooms are almost invariably vaulted or domed; the light descends by small polygonal apertures, and produces the most singular and picturesque effects as it breaks through the volumes of rising steam upon the scene below, and tinges the shaven crowns and bushy beards of the believers in Mahomet. Figs. 2 and 3, Plate III, are a plan and section, being an interesting example of a double bath for men and women.

There is but little reason to doubt that the cause of the disuse of public baths for long years back has been just the reason why they are now re-established. The question turns wholly on the density or scantiness of the population. Devastated as all Europe was after the inroads of the northern nations, few and scattered as was their population, the necessity for such establishments did not exist. The bather could without difficulty resort to the clear pool or bright river, and as it is in crowded assemblies the need of artificial ventilation is felt, so it is in an increasing population the need of readier methods of purification must be resorted to. And this commences the second portion of the task here undertaken.

BATHS (MODERN) AND WASHHOUSES.

Requirements arising in society very slowly and gradually, and which do not depend on any great fact or marked event, are always the most difficult to understand and the latest to find a cure.

As society is now constituted, it is too often the case that evils of this description are first detected by the eye of some pretender, who has a nostrum to propound for every disorder, who exaggerates every evil for the purpose of exalting his own self and his own remedies. The frequent repetition of this system has caused the public to be cautious in listening to complaint, and suspicious of receiving remedial suggestions.

The charlatan is without doubt one of the greatest causes of "obstruction", as it has been called, in the present day, and perhaps in no instance is this more signally evident than in all matters which the vast increase of our population has affected.

Day by day, the tide of population has rolled onwards. Day by day, for years, there has been a steady increase, in a steadily increasing ratio. From 1650 to 1770, our population doubled; it has since doubled again! Four persons now feed where one fed, four persons reside in the same town where one formerly did. Four persons demand air, water, cleanliness, moral opportunity, and moral checks, where one formerly required them. The change in habits, the crowding together of the population, the struggle to get four times the water from the same fount, the difficulty to maintain air fit to breathe, when four times the number are huddled together where formerly one respired freely,—these are all evils that have gradually made their way, and necessitate the formation of establishments contrived to supply the increased sanitary requirements.

Of all the expedients for the health and comfort of the inhabitants of towns and populous places, that have been devised of late years, none has been more successful than the institution of baths and wash-houses. It has already done much, though in its infancy, and promises to do much more. It is hardly true that we are not a bathing nation, and do not understand the comforts of a complete ablution. Every one will remember that at one time every school-boy learned to swim, and throughout the summer months, wherever there was a river, or a clear sheet of water, it was an eager resort for hundreds of active bathers. In almost every gentleman's garden, where clear water could be got, there was the little bath room, with its quaint Dutch tiles, and little lantern-light, filled with pale stained glass. But now, when every river is polluted by the sewers, when a spreading population has rendered it impossible to bathe in open streams with common decency, when the supply to every bath and closet is guaged by the eager eye of the company's official, and charged at a rate that formerly would have paid the ground rent of the house, it behoves us to have resort to other means, and to supply, by the aid of science, that which circumstances beyond our control have deprived us of.

Again, in open towns, when every house had its garden, and the chimneys were so few that the dreaded enemy of the housewife, "the blacks", did not undo her work,—when, in case of rain, there were out-buildings in which the reeking linen might be suspended, and so the domestic hearth kept free, the necessity for the artificial system of washhouses was not felt; but, when dwellings are crowded close together,—when gardens and yards are swallowed up by bricks and mortar,—when chimneys are multiplied, and out-buildings become rare and dear,—when water is scarce, and fuel expensive,—then is the value of this system felt and acknowledged.

Like most salutary institutions, it has been of slow growth. It originated at Liverpool, as long back as the year 1832, when first it was proved that the best check to cholera was cleanliness. In one of the poorer parts of the town, the wife of a labourer rented a small out-house, in which she had the wealth, not

> "Ex ære lebetas
> Cymbiaque argento perfecta, atque aspera signis",—

but a common washing copper. By the kind subscription of some ladies, aided by the weekly contribution of the mighty sum of a penny from themselves, the neighbours were supplied with hot water. An ingenious network of cords was stretched from back window to back window, and by these humble means, directed and assisted by the kindness of these ladies, no less than eighty-five families per week were relieved from the nuisance and unhealthiness of washing in their own crowded apartments. This suggested the idea of building a set of common washhouses, and uniting the advantages of bathing to them; and in May 1842, the first regular establishment was opened at Liverpool. It succeeded so well, that it was soon followed by one of six times the size, the continued success of which was so great, that public attention was called to the subject throughout the country. It was not, however, till October 1844, that a public meeting was held at the Mansion House on the subject, and strenuous efforts made to erect an establishment in the metropolis. So great, however, were the difficulties, that it was not till November 1845, that possession was obtained of the ground, and the first stone laid in December of that year. Difficulties, delay, and expense of every kind, seemed flung in the way of the enterprise, and one-half the establishment only could be opened by July 1847; in the meantime, the committee had, with great exertions, obtained an act of parliament to encourage the establishment of public baths and washhouses. It is unnecessary to relate the history of the struggle, or to state any of the arguments used against the system.

So entirely different, however, have been the results from

what was generally anticipated, that instead of thrusting the buildings out of sight in any hole or corner, it was found desirable to place them in the most conspicuous spot, and to make them not only valuable, but ornamental structures.

The bill, which received the Royal assent on the 26th August, 1846, is headed the 9th and 10th Victoria, chapter 84, and is intituled "An Act to encourage the establishment of Public Baths and Washhouses". Of the provisions, the following are those which bear more immediately upon the present purpose:—Sections 3 and 4 enact, that the council of any borough may, if they think fit, adopt the act absolutely; and that the expense of carrying the same into execution shall be charged upon the borough fund, and the income arising be carried to the same; and that a separate account shall be kept, called the "Public Baths and Washhouses Account".

Sections 5 and 6 enact that, on the requisition of ten ratepayers, the churchwardens of any *parish* may convene a meeting of the vestry, giving seven days' notice; and if it be resolved by such vestry that the Act be adopted, a copy of such resolution shall be sent for approval to the Secretary of State, but no resolution shall be deemed to be carried unless two-thirds of the votes be in favour of the same; and that not less than three persons, nor more than seven, be appointed Commissioners for carrying the same into execution.

Sections 24, 25, 26, and 27 give Commissioners power to appropriate borough lands, or parish lands, as the case may be; or, if not, to purchase or rent the same to build baths, washhouses, etc., or convert buildings for that purpose, and alter and amend from time to time; to enter into contracts of all kinds, but no contract above £100 to be entered into without notice by advertisement; if Commissioners think fit, they may purchase existing baths.

Section 31 and 32 empower the Council to make sale and exchange of lands with consent, and also to sell, after seven years' trial, any baths that may be found too expensive to be kept up.

Section 36 enacts, that the number of baths for the labouring classes shall be not less than twice the number of any higher class, if but one; or of all the baths of any higher classes, if there be more than one of such higher class.

In the next year, it was found necessary to amend this act in a few particulars; accordingly, the 11 and 12 Victoria, cap. 61, intituled, "An Act to amend the act for the establishment of Public Baths and Washhouses", received the Royal assent, 2nd July, 1847.

Section 4 incorporates the Lands Clauses Act, 1845, with this Act, but provides that the lands may be taken by agreement.

Section 5 enacts the same proportion of washing troughs for the labouring classes, as for baths, viz., twice the number of higher classes, if only one higher class, or an equal number with all the higher classes, if more than one higher class.

The progress of the establishment of baths and washhouses, as above described, was very slow; there were prejudices on the part of the wealthy, but there were also prejudices on the part of the poor. They called it "washing in public," and no persuasion could induce them to believe that there was not something derogatory in availing themselves of this boon; but they soon found that nothing was further from the fact than publicity. The early frequenters—the sensible few that always lead the way to the first enjoyment of offered privileges—soon found that in the washhouses they were, in fact, more private than in their homes. No critical neighbours could remark on the patched or darned apparel that hung in the back garden; they could bring their week's linen in their little covered basket, wash their scanty wardrobes in their own compartment, dry them in their own separate drying closets, carry them home again, "nobody any the wiser", except themselves, in the discovery of such a cheap, safe, and speedy refuge from all the domestic misery attendant upon the ill-starred "washing day", as formerly conducted. There were no "blacks" falling from neighbours' chimneys on their counterpanes,—no tears of vexation keeping pace with the showers that rained the whole "washing day"; when all these advantages became apparent, the establishments soon became full, and were as popular as they were unpopular before.

The best and most convincing proof of the appreciation in which baths and washhouses are held by the public, and the gradually increased use made of their benefits as they became more generally known, will be best shown by the quotation, from the published returns, of a few simple figures.

At the four first establishments in London the increase has been as follows:—

	Bathers.	Washers.
In 1847	143,794	39,418
1848	160,628	61,690
1849	394,557	75,004
1850	595,797	133,177
1851	647,242	142,251

During the month ended July 1852, the receipts at the (now) six metropolitan establishments have amounted to the sum of £2768 : 5 : 5, against £1506 : 3 : 4 in the same period in 1851. The number of bathers was 199,934, against 104,856 in the corresponding month of 1851, shewing an increase of £1262 : 2 : 1 in money, and 95,078 bathers; in the month of the year 1848 the number was 7,934 bathers, and the receipts then amounted to £91 : 5 : 10 only.

The number of persons who have availed themselves of these advantages has steadily increased, till the number has amounted to five times the demand. The women are obliged to wait for their turn at the tubs, and the number of bathers has so increased, that it has cost considerable study to save time in the making and discharging of each bath, and, consequently, to accommodate a greater number of persons. In an establishment in a provincial town, with a population of 20,000, the number of bathers for the *week* ending August the 21st, was 2,016.

The extraordinary success of these buildings has led to the adoption of the system throughout the country. There are now in London seven establishments; at Liverpool three; and there are baths and washhouses, either complete or in progress, at Manchester, Birmingham, Bristol, Maidstone, Bilston, Norwich, Hull, Preston, Oxford, Wolverhampton, Macclesfield, Nottingham, Bolton, Worcester, York, Exeter, Hereford, Chester, Plymouth, Sunderland, Newcastle, Carlisle, Coventry, Belfast, and Waterford, and they are projected in many other places. In fact, they are found to be self-supporting, with scarce an exception, and in most instances they yield a profit.

So short a time has elapsed since their first establishment, and so great were their early difficulties, that the profits at first were nothing; and even now are not to be compared to what they probably will be. As long back as 1848, however, the Hampstead Road Baths produced a profit of £35 in a few weeks; and at Manchester, in the same year, a profit of £30 was realized. The present statistics shew that at Newcastle, when only opened a little more than a year, they paid 4 per cent. on the outlay, and at Chester 3½ over working expenses.

It is evident that the profits must increase as the utility of the system becomes apparent. This is already sufficiently evidenced in those establishments referred to above, that have been in operation sufficiently long to base any calculation, and which all, both metropolitan and provincial, shew a steady increase year after year. Cold and wet as the month of May 1850, was, the returns of four of the London establishments shew an average of £80 per week received, instead of £51, and there is every reason to believe that the profits will be larger year by year. The management will cost no more, and the only additional outlay is for fuel; and even this will not be increased in a large ratio, as steam must be kept up to a certain pressure, and the drying closets heated to a certain temperature, whether they be used by many or by few.

The returns from the Cornwallis Street Baths, Liverpool, for the year 1852, give: amount received, £1,585 : 7 : 10; working expenses, £1,055 : 2 : 10, leaving a surplus of £530 : 5 : 0. At

Birmingham, during some of the summer weeks, the return has been 11,000 bathers, and the receipts £150 weekly. The following abstract of receipts from washers and bathers at this establishment, gives a very satisfactory result, as to the *progress* of these establishments :—

Week ending	Bathers.	Washers.	Total.
Dec. 1851 . . .	£6 : 15 : 4	£3 : 13 : 3	£10 : 8 : 2
Dec. 1852 . . .	13 : 4 : 6	4 : 12 : 3	17 : 16 : 9

Like almost all early experiments, the first establishments have been very costly. It has been found necessary to take down, alter, and refix machinery at an immense outlay; even now it is evident that very great and expensive alterations must take place at many existing establishments before they can be worked effectively and economically.

The combination of practical knowledge, both for the design and construction of the building, and for the adaptation and execution of the machinery, is essential in undertakings of this kind; it is thus only that a unity of arrangement can be preserved throughout, and so a due economy attained.

This consideration is of the utmost importance, as the bare interest of the money, or all extra or unnecessary cost, is a fearful deduction from the profits.

Undue importance is, however, frequently attached to curtailing first outlay in the erection of baths and washhouses, which often in the end proves bad economy, as the extra expenditure caused by any necessary after-addition much exceeds what the entirety would have been if done at first, and the whole is not likely to be so complete; but as it is in some cases a question between a small outlay or no establishment, it may be useful to state that, with favourable position as to site and supply of water, £3,000, or even £2,000, would erect a very useful building, including the best machinery; but it is far better in towns exceeding 18,000 or 20,000 population to make a first outlay of from £5,000 to £6,000.

Two plans are given in Plate I; Fig. 4, representing an arrangement for a large establishment, suitable for the metropolis or a first-rate city, and Fig. 3 such as should be erected for a provincial town with a population not exceeding 20,000;—the subsequent remarks on the details, etc., will generally apply to each of these plans. The larger building contains for men twenty-four first class, fifty-five second class, and three vapour and shower baths, with a plunging bath 16 ft. × 14 ft.; first and second class swimming baths each 65 ft. × 40 ft. On the women's side, fifteen first class, thirty-one second class, with plunging, shower, and vapour baths, similar to men's side. The washhouse department accommodates twenty-one first class, and fifty-two second class stalls, each containing a washing, boiling, and rinsing tub, as well as a drying closet; a washhouse is also shewn in which the business for the establishment, and for washing towels, is carried on. This building could be erected at a cost of about £14,000.

The smaller plan, Fig. 3, is arranged for five first class, and eight second class men's baths, with a plunging bath 17 ft. × 8 ft., two first, and four second class women's baths, a shower and vapour bath on each side, and a swimming bath 35 ft. × 24 ft. The washhouse contains ten washing stalls, arranged precisely the same as the larger plan. The cost of this building is £2,125.

Erections for this purpose should always, if possible, be on one floor only above the basement,—a matter of primary value as regards light, air, ventilation, avoidance of steps, and convenience of arranging pipes, etc.: the only exception being over the entrances, etc., where frequently another story is added, to contain the residence of the superintendant or other officers.

The plan should be made with the greatest compactness to ensure a minimum of cost. The larger establishment shewn covers an area of 2,930 yards, and the smaller of 417 yards.

In the basement should be placed the steam boilers, which, by means of a small engine, perform the duty of pumping water to a great cistern in the roof (of course, if the water is delivered at the level of this cistern by a water company or otherwise, this cost would be dispensed with). The boilers also supply steam for the boiling vessels in the washhouse, for the vapour baths, and any excess is used for warming apartments, heating towel closets, etc. Where inundation is to be apprehended, and it is consequently unadvisable to place the machinery in the basement, the stokery, etc. might be put at the back.

It is important here to notice the great economy attained in a minute adaptation of the waste heat and steam as well as water, etc., all of which may be made available, and thus tend to economise the working expenses.

It is easy, for example, to turn the overflow pipes, also the condensed water, etc. into the swimming bath instead of the drain, that the waste steam, instead of blowing away, should perform some duty; if no better adaptation can be found, it is always useful in the shaft to increase the draft and destroy the blackness of the smoke. In the Lambeth establishment, the authors intend to use the exhaust steam from the pumping engine as the medium of heating the two very large swimming baths averaging 150 feet long by 40 feet wide, and to turn the steam in at an angle with the side of the bath to cause a circulating motion of the water. It is worthy of remark, that in this establishment, the great first class swimming bath is to be filled by means of a fountain, which will keep the surface of the water in rippling motion, and it is believed that, while the latter will prevent the accumulation of what is ordinarily known as scum on the surface, the former will keep a due admixture of the steam-heating medium with the water.

To minor matters, such as the due clothing of pipes and boilers, and all heated vessels, it seems almost unnecessary to refer, and yet, satisfactory results are frequently frustrated for want of due consideration on these points.

As before remarked, much attention has been given to the production of a valve for the supply of water to fill and empty the baths. A patent for an invention for this purpose has been taken out by the authors of this essay, and found to act very satisfactorily; the peculiarity consists in the pressure being at the back of the valve, and in the conical shape of the ground surfaces, into which the column of water at the back always tends to force the plug; the same form insuring tightness with wear. In the centre is a mixing box for the hot and cold water, delivered on either side, so that an equable temperature is maintained, obviating the difference in the degree of expansion and contraction; the cause of leakage in most articles for similar purpose.

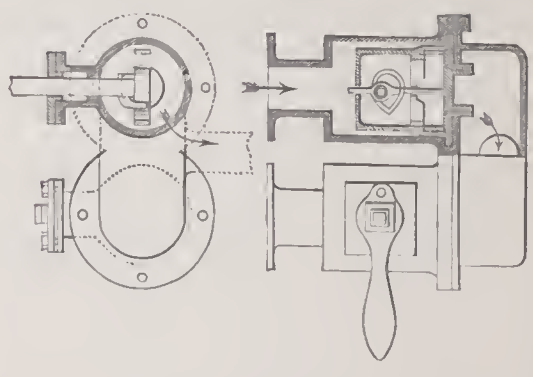


Fig. 5.

A bath can be got ready with these valves in thirty-two seconds. They are manufactured and executed in a very superior manner by Sylvester and Co. of Great Russell Street, Bloomsbury, and Potter of South Molton Street.

As, in establishments of this kind, it is important every thing should be as clean and bright as possible, it is essential that the chimney should be lofty and active, and, if possible, one shaft carrying everything away with it. This shaft is also of great use to ventilate the apartments, especially the washhouse.

The greatest care should be taken in procuring a pure soft water for the purposes of washing and bathing. The value of softness in water, for such purposes, can hardly be estimated, and should always be a leading point of consideration in the selection of a site. The fact that, where hard water is used, 10*s.* for each person is the cost of soap and water—6*s.* 8*d.* for soap and 3*s.* 4*d.* for water in the London district—proves how much economy, in large establishments, is to be attained by a due attention to the quality of this article. Animal deposit and organic impurity may be easily removed by filtering; but the

lime, causing hardness, is not so got rid of. The process of filtration is simple and inexpensive, except where the water is delivered by companies who have not provided proper filter beds.

In the evidence given by Dr. Clarke, printed in the first Report of the Commissioners of the Health of Towns Act, he states, that " Supposing we had the choice of several waters, there is no single quality to which I should attach more importance than *softness*." And again, " With regard to the softness of water, this quality is of importance; not merely for the saving of soap, and agreeableness for washing and bathing, but also in respect to the wear and tear of linen due to hard water."

Dr. Lyon Playfair, in his lecture on the chemical properties involved in the manufactures of the Great Exhibition, gives the following astounding figures in connexion with this subject.

" The annual charge of washing to the metropolis is £1,535,060, which is equal to above a twenty-fifth of the whole capital invested in the cotton manufactures of the United Kingdom. Hard water usually contains lime; and in washing, that earth unites with the fatty acid of soap, producing an insoluble body, of no use as a detergent. For 100 gallons of Thames water, 30 oz. of soap are thus wasted before a detergent lather is formed. In personal ablution, we economise this excessive waste by the uncomfortable practice, universally followed in London, of taking about an ounce of water into the hands, and converting it into a lather, the water in the basin being only employed to rinse this off, instead of aiding in the detergence. But in washing linen, this plan cannot be followed, every particle of lime being removed before the soap becomes useful; this, as a matter of economy, is frequently accomplished by carbonate of soda, as being cheaper than soap. The amount of soap and soda thus wasted in the metropolis has been stated to be equal to the gross water rental."

In arranging buildings for the purposes of baths and washhouses, there should be an absolute division effecting an entire separation of sexes. The centre should comprise a residence for the superintendant, waiting halls for both men and women, pay office, etc., with the swimming baths, etc.

At the establishment at Maidstone, a range of private bath rooms have been constructed, and fitted up in a superior manner as regards furniture, and with a towel closet heated with a coil of pipes, and with the apparatus for vapour or shower baths. These rooms average 9 ft. × 8 ft., making a superior class, reserved for a higher rate of charge.

The swimming baths should be made with a surface light and clean, and it is important it be non-absorbent; glazed bricks have in some cases been used, and are defective only in the number of the joints: slabs of terra cotta, 9 ins. square, and 2½ ins. thick, are made by the Llysnewydd brick Company, Swansea, with a glazed surface, in white and blue colours; these have been used, and form a very beautiful bath; the dressing boxes ranged round the bath, are constructed of wood framing, they are each 4 feet long, by 3 feet wide, with a seat, hat pegs, and a wood foot grating in each.

Fig. 8, Section.

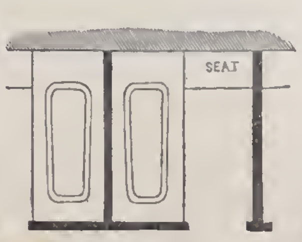


Fig. 6, Plan.

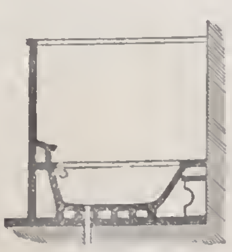


Fig. 7, Section.

Baths are made of copper, zinc, glazed tiles, slate, marble, or of glazed porcelain in one piece. Very many experiments have been made, and a variety of conflicting opinions given on the relative value of each material; the objections to those which require a painted or enamelled surface are obvious, in the action which the water and soap are found to exert on the composition of these surfaces, which contain generally a large amount of oleaginous matter.

The glazed tile baths are much approved, and of late years have been very generally used; but by far the most perfect bath is that of glazed porcelain in one piece.

The walls or sides of these are about two inches thick, in which fine clay, china clay, and the glaze, are so assimilated, that the two clays are of the same porosity, bear the same heat, and expand and contract together, and the glaze will melt only when the fine clay is sufficiently burned. These baths avoid the only objection to the tile baths, viz. the frequent joints, and consequent irregularity of surface. They are made of the following dimensions, 5 ft. 3 ins. long, 2 ft. 4 ins. wide at head, 2 ft. at foot, and 1 ft. 11 ins. deep. They have been brought to perfection after a long and expensive series of experiments, for which much credit is due to Mr. Rufford of Stourbridge, the manufacturer, and his energetic coadjutor, Mr. Paul Mathews.

In fitting up these bath rooms, it is important, as much as possible, to adopt the use of material which is not injured by steam or moisture; and for this reason, the looking-glass frame, soap dish, handle to door, clothes' pegs, etc., are all made in porcelain, so as not to be liable to rust or contract dirt. An elaboration of this is intended to be executed by the Llangollen Slate Company, in the new Lambeth Baths and Washhouses. The first class men's baths are placed in a gallery, round a portion of the great swimming bath, supported by iron brackets and columns. The slate divisions and the doors will be enamelled, so as to give them a pure white glaze.

The divisions between the baths and washing boxes shown in the plans, and also in the details, Figs. 6 to 12, are made of slate, with slate doors, answering all the purposes of privacy, at the same time that no impediment is offered to the free circulation of air throughout the one large apartment.

The compartments in the washhouses shown on the plans, are each complete in themselves, viz. they should contain a washtub, B, Fig. 9; a vessel for boiling clothes, C; a tub for rinsing, A; D, wringing board; and a drying closet, as shown Fig. 10. The arrangement of these compartments is exhibited in

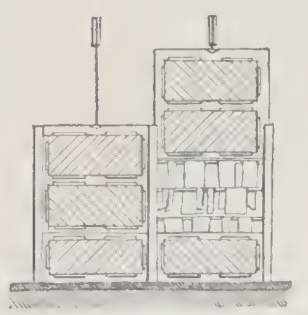


Fig. 11.

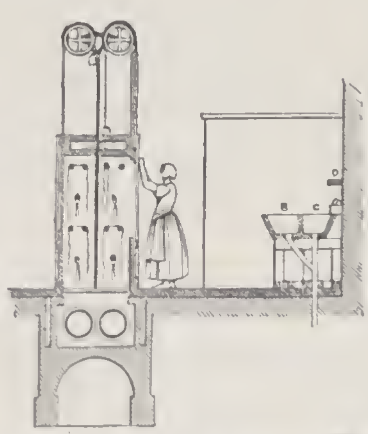


Fig. 10.

Fig. 12.

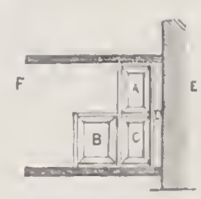


Fig. 9.

detail in Fig. 9, plan of tubs; Fig. 10, section of washing and drying closets; Fig. 11, elevation of two drying closets, one with the door raised, the other shut; and Fig. 12, section of stall at E F, on Fig. 9. The rinsing tub is a feature not universally adopted: it has the great advantage of saving the necessity of discharging the heated and softened water from the washtub, and thus economizes fuel. Each compartment should have a perforated foot-board, raised a little above the floor, and the tubs should be heated by steam.

It is advisable, when the site will admit of such an arrangement, that a separate entrance should be given to the washhouse, distinct from the baths, that no confusion in the different departments should arise. In the former, hydro-extractor wringing machines are provided to each group of washing compartments, in the position shown on the plans; these, in the course of a few seconds, remove fifty per cent. of the moisture from the linen, and consequently facilitate the rapidity of drying.

The following table of the results of washing, wringing, and drying, at the Goulston Square establishment, exhibits the value of these wringing machines :—

Description of Article.	Weight when dirty and before being washed.		Weight after being washed.		Weight after the wringing process.		Weight when taken from the drying-chamber dry.		Time employed wringing.	Time employed drying.	Temperature of the drying chamber.
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	Min.	Min.	Deg.
12 bathers' towels	7	11	16	12	11	12	6	12	2	30	200
ditto	7	13½	16	15	11	13	6	14½	2	25	210
ditto	7	15	17	1½	11	14½	6	15½	2	35	190
3 fine sheets .	4	15½	13	2	8	4	4	3½	2	15	180
3 middling do. .	5	4	14	1	8	3	4	12	2	25	190
3 coarse ditto .	7	8	16	2	9	0	6	15½	2½	30	190
3 small blankets	6	15	22	15½	9	10½	6	3	2	15	200
ditto	6	10	21	4	9	1	6	0	2½	15	200
3 large ditto .	9	1	24	14	12	3	8	12	3	25	210

The object of contriving the whole process of washing and drying in each compartment, is obviously for the sake of privacy; and, in provincial towns, must be of even more importance than in the metropolis, where it is less likely that the occupant will meet with any one of her acquaintance. It is necessary to seek an arrangement that shall prevent the necessity of exposing the possibly ragged linen of a washer to her neighbours, or congregate any number of them together—a rendezvous for gossip.

The method of having the drying horses together in one place, away from the washing box, although the easiest to construct, is decidedly objectionable, being a place of lounging, and does away entirely with the comfort and privacy the other plan gives; and this is, as before observed, a point of vastly greater importance in a provincial town than in the metropolis.

The system formerly pursued of heating drying closets by steam has been found so imperfect, that other methods have been sought, by which greater rapidity in drying could be attained. It is well known by brick makers, that however hot the day may be, the bricks will not dry unless there be some movement in the air, to carry off the vapour as soon as formed; the same fact is also observed in the process of drying hops; in haymaking, and, in fact, everywhere in which quick drying is necessary. Injected currents of highly dessicated air in rapid volumes, imitating the rush of the hot winds of eastern climates, whose rapidly drying powers are the wonder of Europeans, will be found to be the most successful principle.

At Maidstone, where there is a steam-engine, an apparatus something on the principle of the centrifugal pump has been fitted up for this purpose. At Bilston and other places, where there is no engine, a system has been adopted of causing air to pass through red-hot coke, and thence diffusing it by a series of pipes, so as rapidly to circulate through the wet linen.

The results of the first described closets, with a temperature of only 130°, has been that heavy blankets have been perfectly dried in twenty minutes, and light articles in *three minutes*.

No accommodation is necessary for ironing and mangling. In some of the establishments, where they have been provided, they have been found comparatively useless, even in London; and in a provincial town, we should think them positively objectionable, as the ironing is not unhealthy to be done at home, and the mangling is a small source of living to many poor persons, which would be lost if it were done in a public establishment.

In the report also of the Goulston Baths, in 1848, after detailing the number of washers, driers, etc., it is observed: "No ironing appears to have been done." If it be considered advisable, however, to have such accommodation, a room is always easily added for that purpose, as it is entirely distinct from the other processes.

An addition of great value has been made to these establishments at Liverpool, and, up to the present time, we believe, at Liverpool only: a place set apart for washing infected linen,—it should be entirely detached,—in which the clothes of persons ill of infectious disorders are received and washed for them without any charge, a note from a medical man being all that is required to procure this aid.

A novel addition of great value to the washing establishment, is intended to be made at the Lambeth Baths and Washhouses, in adding an infant school, where the poor washers may safely leave their young children, while they are engaged in the wholesome duty of purifying the household linen. The fact of being obliged to leave an infant at home, exposed to all the chances of accident and neglect, have deterred at least one-half of those who would gladly have accepted this boon, afforded by the new washhouse, from availing themselves of it. In this instance, the authors have given a room for the children of those engaged within; and the kindness of the directors will provide a competent person to assist in their care, and, as much as can be, in the development, of their youthful minds.

Buildings for the purposes of baths and washhouses should be erected in a substantial manner; all superfluous ornament, and the adaptation of Gothic or other masks, ought to be forbidden; a character of cheerfulness should be given to them, which the architect will know well how to stamp with an expression of its purpose.

The internal fittings should in all cases be of the simplest and strongest kind, and, wherever possible, of a material not liable to corrode: the rooms should be lofty, finished quite plainly, and left white, with a strict avoidance of dark corners, or places in which dirt could accumulate. The roof shown in Fig. 13, constructed on the ridge and furrow principle, of substantial construction, and covered partly with glass and partly with slate, is admirably adapted for buildings of this character.

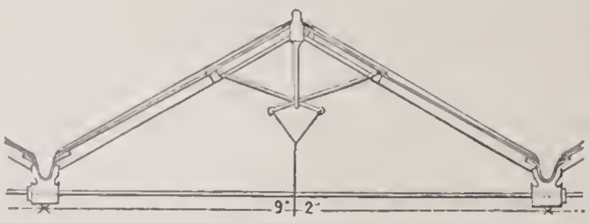


Fig. 13.

One of the most important considerations in the erection of these establishments, is the selection of a fit site.

First, then, it should be in a position in which it could be supplied with an unlimited quantity of *soft* water; secondly, it should occupy a prominent position, to be seen by every one; thirdly, it should be central, and have good approaches.

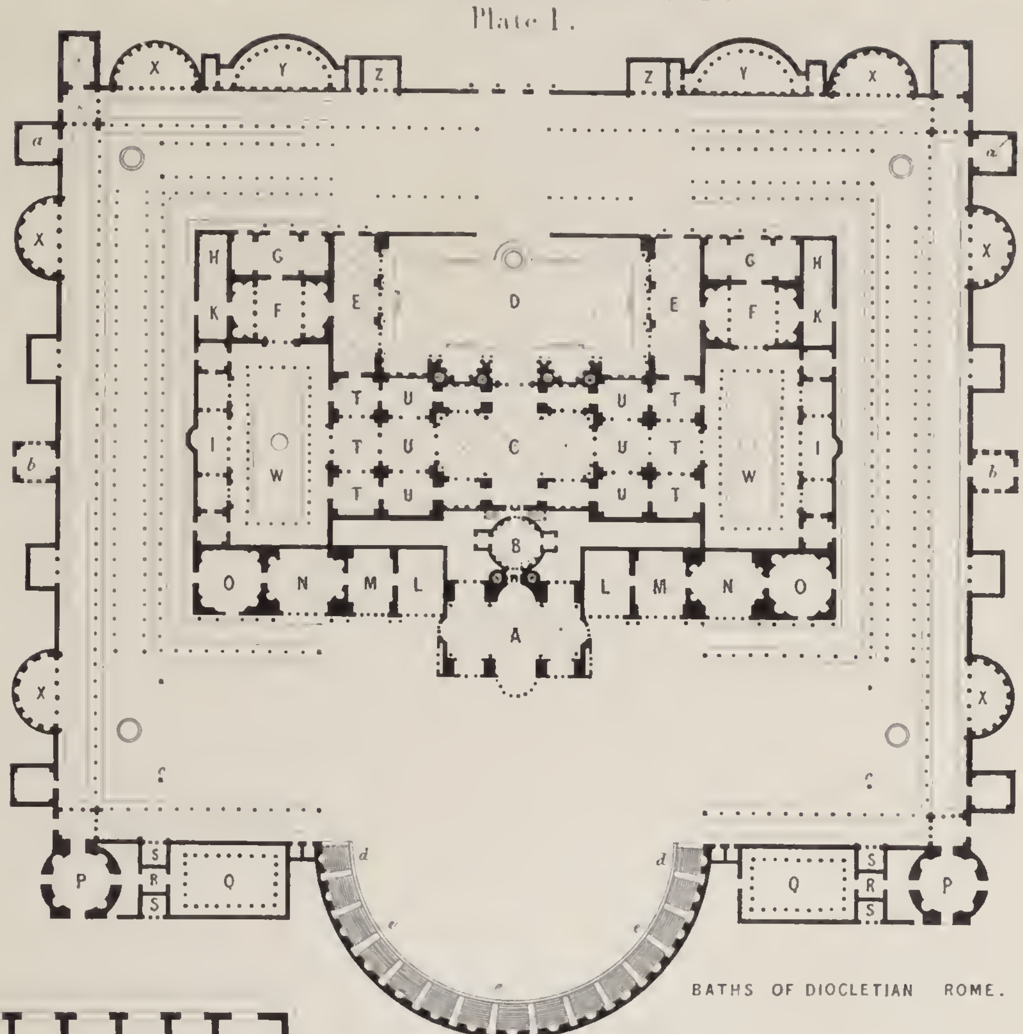
The principles above detailed, but in a modified form, may be well carried out for the use of hotels, and even of private houses, with the most beneficial effects as regards comfort and economy. In hotels, particularly, the saving of labour and time in the washing, and the convenience of thoroughly drying and airing linen for immediate use would be most sensibly felt; and by combining apparatus for the baths with these, would prove a very beneficial speculation.

Large sums are cheerfully spent for the shelter of the lunatic, and for the punishment of the culprit, and it is hoped that there will be no stint in the expenditure of much less sums for the improvement of the moral and physical condition of the labourer; the more so, as the money is but lent, as it were, for a time. The union house, the lunatic asylum, the prison, are all connected with saddening ideas—all are necessary evils; but every establishment that elevates man in his moral organization diminishes these evils; and if it be true, as the concurrent testimony of all wise and good men has confessed, that "cleanliness is next to godliness", we must rank these institutions as next in worth and importance to our schools. Even if we take lower and more selfish views, we must consider that these establishments are self-supporting, if not remunerative; and we must remember that the pestilence of the nineteenth century, though it requires dirt and filth to generate its first breathings, yet, when arrived at vigour and activity, it sweeps on like the simoon, and strikes down the rich as well as the poor. It is too much to expect of any human institution that it shall eradicate all evil, and cure all disease; but when a remedy is known, either moral or physical, heavy is the responsibility of those who can use it, and will not.

ASHPITEL AND WHICHCORD,
Architects and Engineers.

BATHS AND WASHHOUSES.

Plate I.

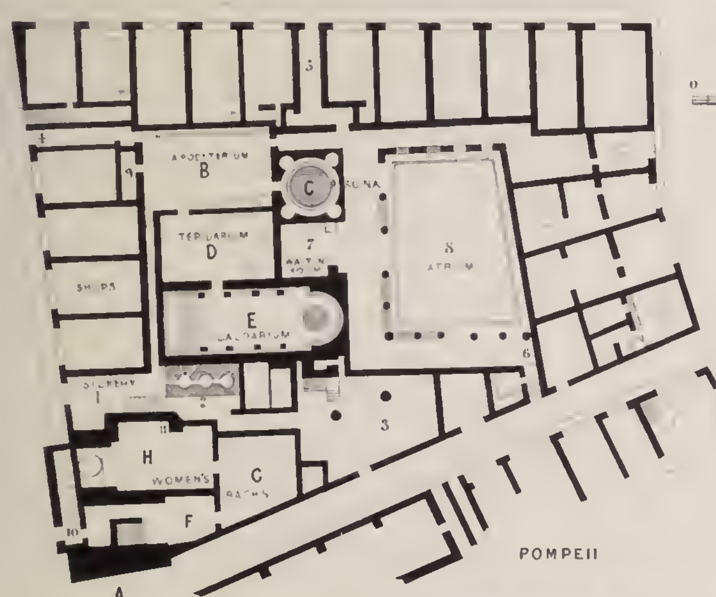


BATHS OF DIOCLETIAN ROME.

0 100 200 300 400 500

Scale of Feet.

Fig 2



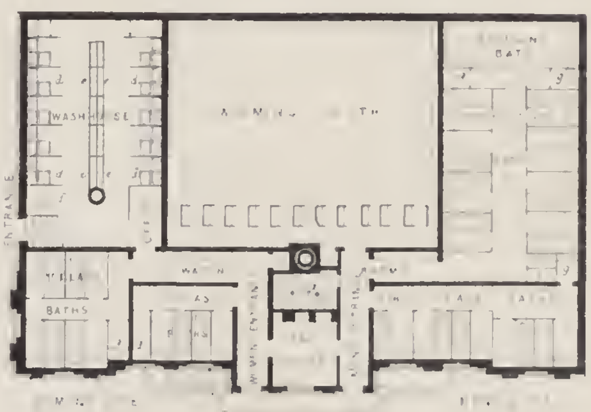
POMPEII

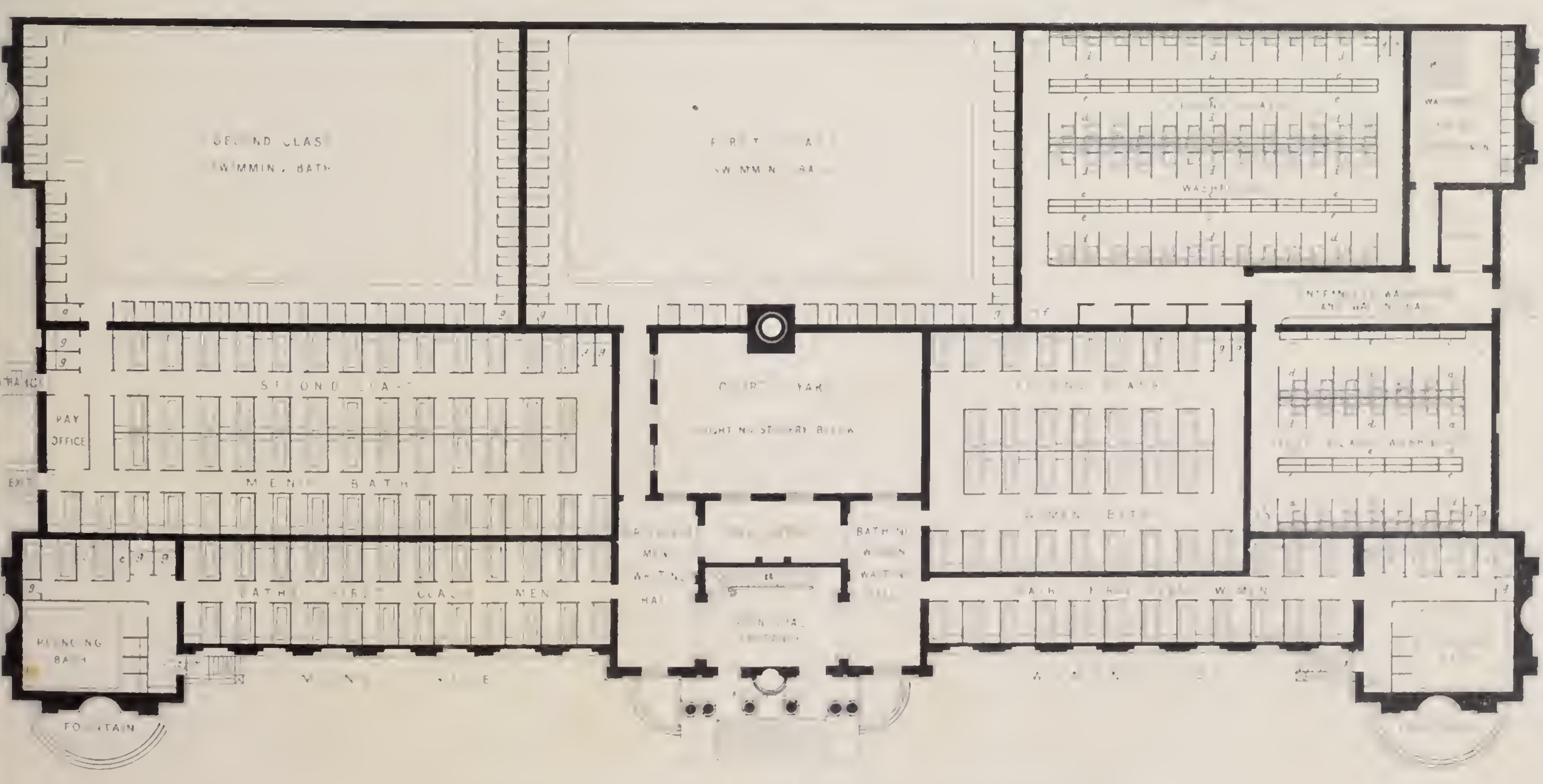
10 0 10 20 30 40 50

Scale of Feet.

REFERENCE TO FI... & 4

- *a* Stairs up to Superintendent's Residence Board Room &c
- *b* Stairs down to St ...
- *c* Vapour & Shower Baths
- *d* Wash Tubs
- *e* Drying Closets
- *f* Wringing Machine
- *g* Water Closets



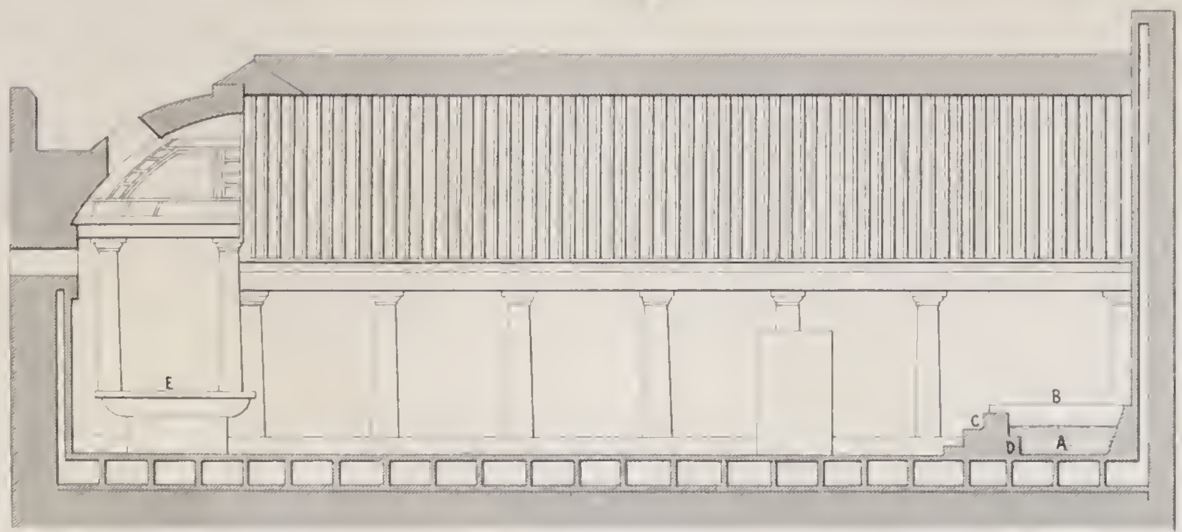


10 5 0 10 20 30 40 50 60 70 80 90 100

Scale of Feet to Figs 3 and 4.

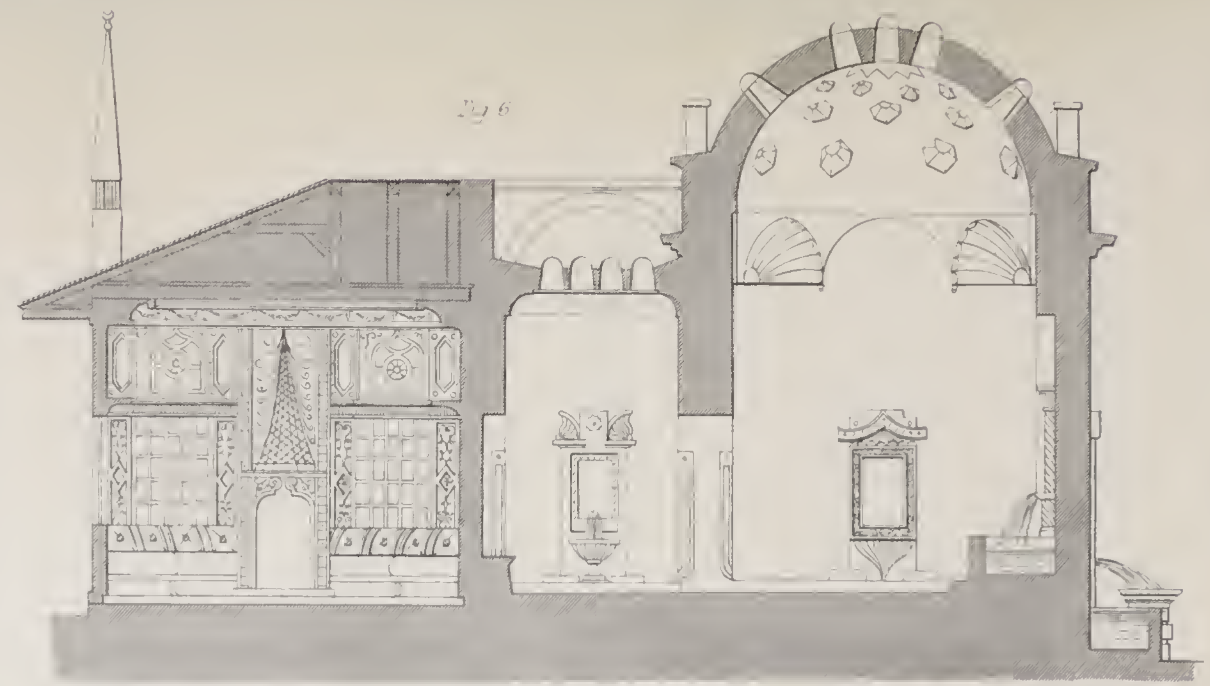
BATHS AND WASHHOUSES.

Plate 2.

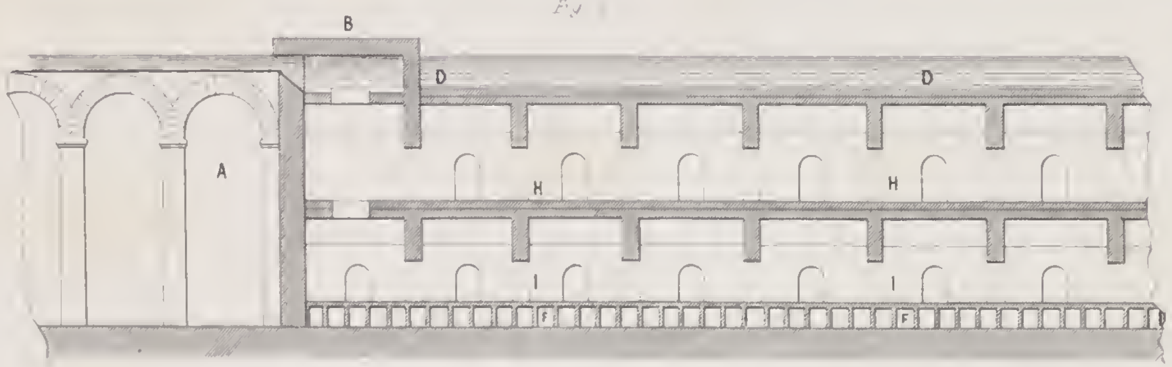


SECTION OF THE CALDARIUM POMPEII.

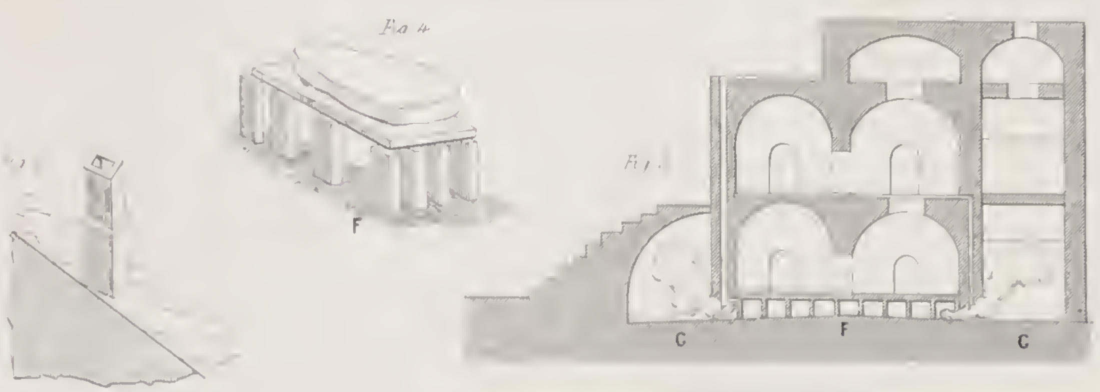
From Sir Wm Gell's Pompeii



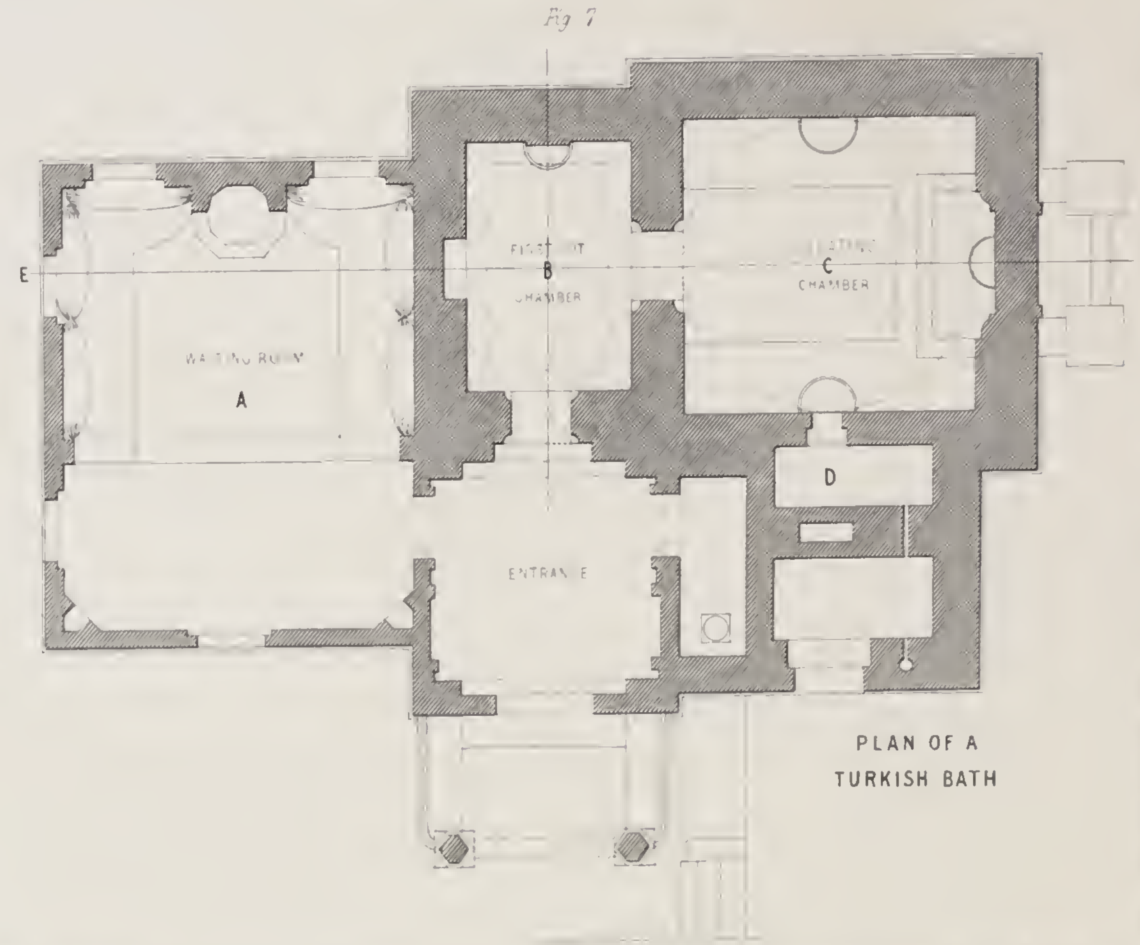
SECTION ON LINE E F ON PLAN FIG. 7



CASTELLA OF ANTONINUS



SECTION AT B. FIG 2.



PLAN OF A TURKISH BATH

BATHS AND WASHHOUSES.

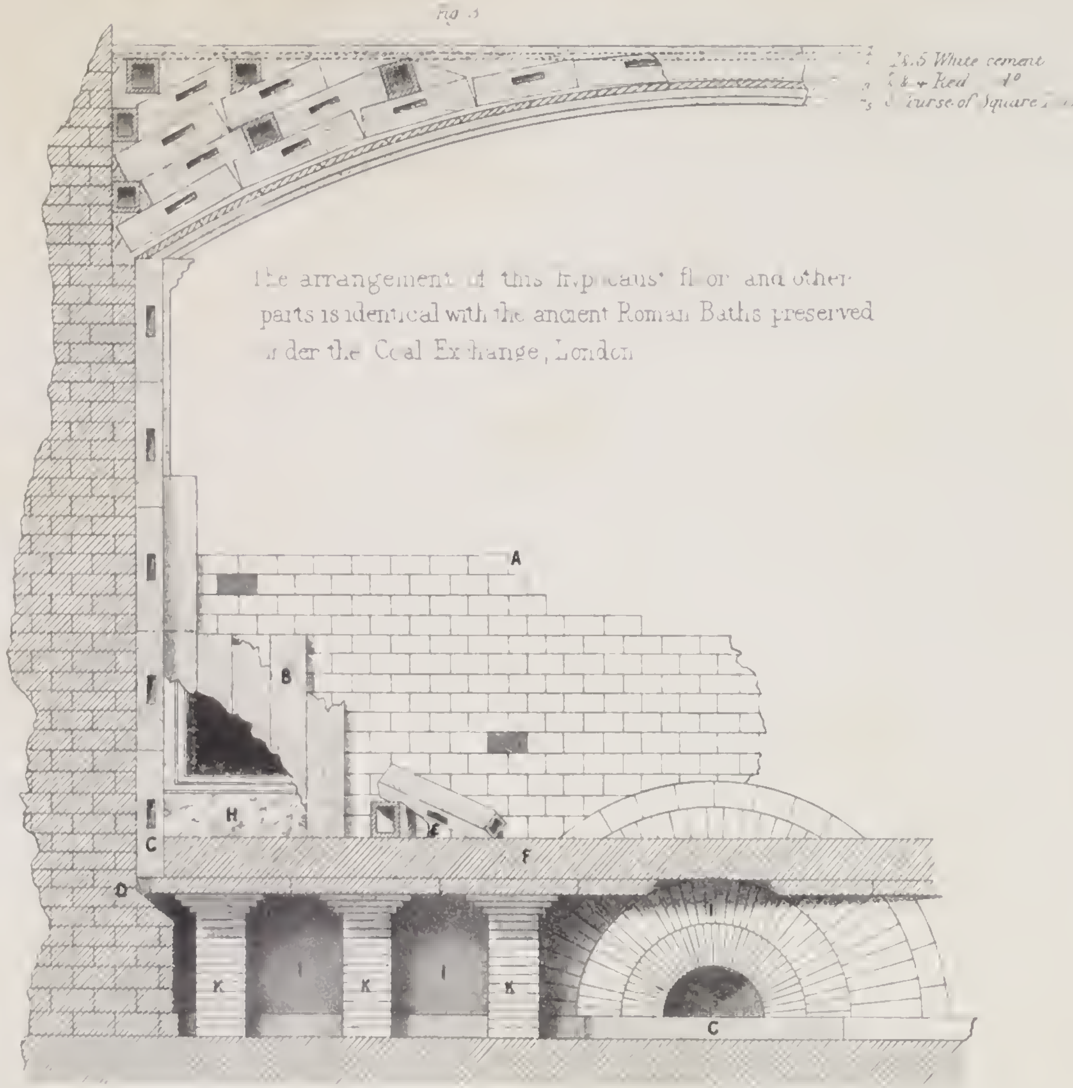
Plate 3.

SECTION OF THE HYPOCAUST AND OF ONE OF THE CHAMBERS OF THE ANCIENT ROMAN BATHS AT AUGST. BASLE, (AUGUSTA RAURACORUM)

showing the construction of the floors walls vaultings &c from a drawing in the possession of Professor Donaldson copied from the original one by Mons^r Aubert Parent French Arch^t made on the spot in 1803

A Solid construction of the walls
B Hollowed bricks attached to face of walls
C Section of bricks in walls with holes for current of warm air
D Passage for communication of hot air from hypocaust up into the hollowed bricks
E Attached hollow bricks
F Floor formed of cement &c
G Opening of the furnace
H Plastering coating laid on the hollowed bricks and decorated with paintings
I The hypocaust
K Square brick piers with cappings surmounted by large square tiles or bricks to receive the cement floor

Fig. 3

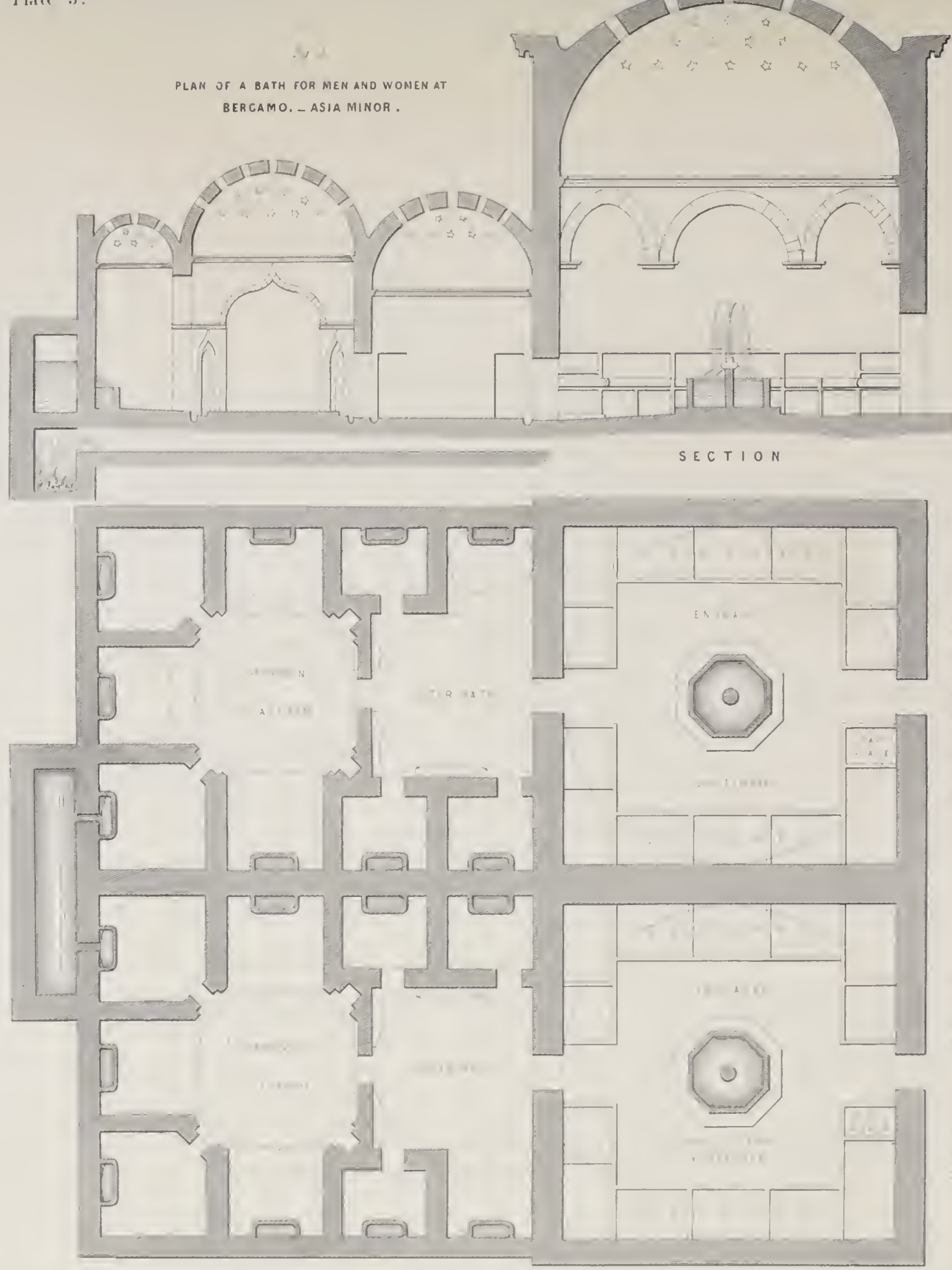


The arrangement of this hypocaust floor and other parts is identical with the ancient Roman Baths preserved under the Coal Exchange, London

Scale of English Feet

Fig. 4

PLAN OF A BATH FOR MEN AND WOMEN AT BERGAMO. — ASIA MINOR.



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CAMPANILE.

ILLUSTRATIONS.

Plates 1, 2, 13, 14, 15, 25, and 26.

Campanile is the term appropriated to a certain class of towers, chiefly devoted to religious purposes in Italy. Whether in the Lombard or Romanesque style, or in that of the Revival, they form so conspicuous a feature in the country in which they are found, present so many points of interest, and are so suggestive of varied and beautiful ideas, that they can scarcely fail to have been the object of especial study, and attention, to the professional traveller.

Similar in purpose, to the superb belfry-towers of the north of Europe, though differing widely from them in style of art and design, they equal their rivals in point of dimensions and constructive skill; and, in many instances, are scarcely inferior to the finest examples of pointed architecture, in beauty of outline, and well-adjusted proportion of parts.

Although it must be admitted that the earlier styles to which, in many cases, they belong, are inferior in resources, and less adapted for producing the pyramidal, and gradually tapering, outline which has become predominant in this species of composition, so fully developed in the magnificent campanili of Cremona, Modena, and many other towns, particularly in Milan, Genoa, and their neighbourhood; nevertheless, amongst even the earliest and rudest of the works of this class, a beautiful simplicity of form and outline is found, so interesting and so remarkable, as to have been conventionally adopted by artists, as a leading feature in all Italian landscape scenery.

It is then to Italy, that the Architect naturally turns for examples, through which to trace the origin, and to elucidate the history, of the present subject of consideration. He finds that there is at Rome, and Ravenna, a large class of these monuments, evidently the most ancient, and used as the type for all later buildings of this description; at present, especially in Rome, these examples are incongruously mixed up with constructions, either of earlier, or more frequently of much later, date, so that it is difficult, by comparison with the edifices to which they are attached, to establish any proof of their age: these being, however, without doubt, the earliest campanili erected, it becomes easy, if a true date be assigned to them, to trace the after progress of other works of the same character.

It is to be observed, that these buildings present themselves, scarcely so much adjuncts to the church, as entirely new and principal features, intended for a particular purpose; and as it is obvious that the use of bells gave birth to them, the first point of enquiry is as to the reception of bells into the service of the Christian Church.

It seems universally admitted, that about A.D. 400, Paulinus, bishop of Nola, a city of Campania, was the first so to use them. The tintinnabula, subsequently introduced by Pope Leo I, A.D. 458, were so small, that six or eight of them could be rung on one wheel. In 605 it was formally appointed by Pope Sabinian, that the canonical hours should be distinguished by the ringing of bells, which, from that time, appear to have become more common. Pope Stephen III is said to have placed three bells in a tower on the old basilica of St. Peter's, in 752-757, and they were used in churches, by order of Pope John IX, about 900.

In England, bells were used, before the conclusion of the seventh century, in the monastic societies of Northumbria; and it is said, as early as the sixth, in those of Caledonia. Ingulphus mentions, that Turketulus, abbot of Croyland, who died about 870, gave a great bell, which he called Guthlac, to the church of that abbey; and about a century later, six large bells were added, all of which rang together. In 950, S. Dunstan caused two large bells to be cast for the church at Reading; not long after this date, Kuseus, archbishop of York, gave two great bells to the church of S. John, at Beverly; and at the same time ordered, that other churches, in his diocese, should be provided with like appendages. Distinct mention of their constant use, in every parish church belonging to the Saxons, is found in the laws of Athelstan: so that it is not probable that in England we have any existing bell-tower, of earlier date than the time of Alfred the Great. Batissier (*Hist. de l'Art Monumentale*) asserts that the use of bells was known in France earlier than the seventh century: it is said as early as 550. Millin (*Dictionnaire des Beaux Arts*) cites the tower of S. Denis, near Paris, as one of the most ancient in France. The church to which it belongs, esteemed in that country as the greatest work of the seventh century, was commenced by Dagobert I, who died in 638, and continued by his son Clovis II, who died in 656. Pepin restored, or rebuilt, this abbey, which was consecrated by Charlemagne, in 775.

D'Agincourt says, that one of the existing towers of S. Germain-des-Prés, at Paris, is a construction of the sixth century. The abbey, at first called, "of S. Vincent", was built by Hildebert, in 550 (the bishop, S. Germain, being the Architect); and so remarkable and rich a church was it considered, that it obtained the title of S. Germain la Dorée. This church having been destroyed, or more probably much damaged, by the Normans, was rebuilt in 990.

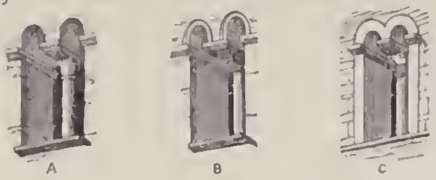
There was an octagonal bell-tower, with semicircular arched openings of the sixth century, formerly standing in the garden of the Innocents, at Paris. In the reign of Charlemagne, 768-814, a monk named Fauchon was in much repute for his skill in bell-casting; but upon the whole, it would appear that the use of bells in France cannot have been general earlier than the end of the sixth, or beginning of the seventh century; for it is said, that in 610, the alarm caused by the noise of the bells of the church of S. Etienne, at Sens, put to flight the army of Clotaire II, then besieging that town; a circumstance which sufficiently proves, that the sound must at that place and time have been uncommon, although it also proves that the bells must have been of considerable size.

The dates above quoted, as to the first introduction of bells, it is admitted, rest for the most part on but slender authority; it may, however, be considered, as sufficiently established for the present purpose, that the use of bells was certainly not common before the seventh century.

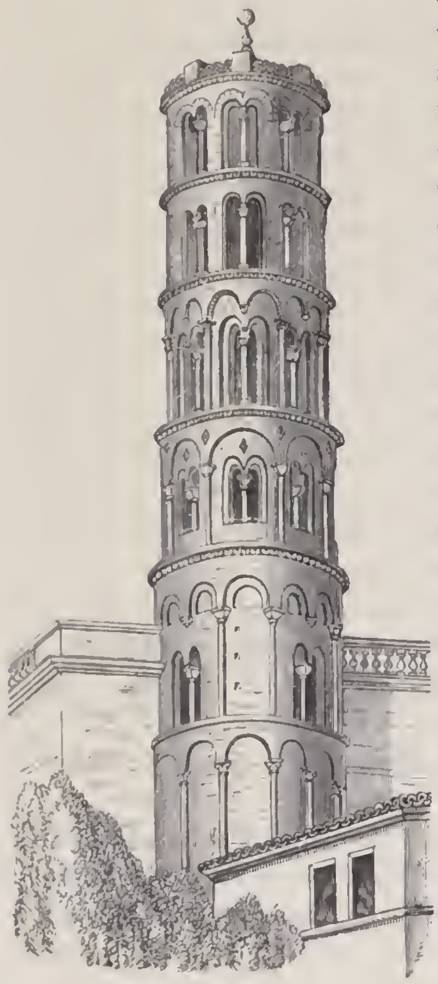
Having thus endeavoured to find a starting point in the chronology of bell towers, reference may now be made to their architectural character, as our further guide in this investigation. If the age of the early campanili is to be decided by comparing them with structures of similar architectural character, nothing, perhaps, so closely resembles them as the building at Ravenna, called the Palace of Theodoric, which, if not of his time, 493-526, is probably not much later. This building is decorated with arches springing from capitals, which may be termed, as by Professor Whewell, "cushion capitals", projecting as double corbels, in the direction of the thickness of the wall, over them.

In the early campanili, this form of construction prevails, not

only in Italy, but in England, as, in some of the churches of Lincolnshire, from which three examples are here given; A,



from the church of S. Peter in Gowts, Lincoln; B and C, from Coleby church, furnish perfect examples. These buildings are probably of the eleventh or twelfth century; but we have other and earlier examples with the balluster column and cushion capital, at least as old as the tenth century; but these do not so nearly resemble the campanili, as do the bell-towers of Lincoln. In Germany are many similar to the earlier as well as to the Lincolnshire examples. And in France, too, the feature is not wanting; the tower of the cathedral of Uzès (from a drawing by Mr. James Bell) is a very fine and illustrative example.


Cathedral, Uzès

There is a certain resemblance in this cushion, to the square block which crowns the capitals of columns, in the churches of Ravenna of the fifth and sixth centuries, and in the early churches of Rome; but in these capitals there is more refinement, than in the plain corbelled work of the early campanili.

Having alluded to these analogies in form, which help us to an approximate date, it may be well to consider what facts in history may be further fitted to elucidate this subject.

Upon the removal of the seat of empire to Constantinople, A.D. 328, art began to decline, and its fall was continual and rapid, until the extinction of the Western Empire. During the reign, however, of the Goths in Italy, and of the Lombards, from 500 to 772, although a period of great anarchy and confusion, architecture was encouraged, and several important works were executed, founded on the model of the debased works of latter Roman times; and it is to this period, that is to be attributed the erection of the early campanili of Rome and Ravenna.

Theodoric, who began his reign in 493, and sustained it for the then unusual space of thirty-two years, was especially careful to maintain the walls, and public buildings, of Rome. He established his capital at Ravenna, enriched it with several buildings, and had, probably, both more opportunity and more desire to promote the arts, than any other king, either of his own or the Lombard race.

Hope (*Hist. Essay*) states, in alluding to the immense basilicas built on the first burst of Christianity, that the only universal addition in Rome to the former sacred structures, was, after steeples had begun to spring up in the seventh and eighth centuries, that of one of those appendages to each of the old churches.

In the absence of positive dates, there does not appear any evidence why the campanili of Ravenna may not date back as far as the beginning of the sixth century; nor is there anything in their character, which should preclude their being as late as the end of the eighth, or beginning of the ninth, centuries; but it is not probable that they are later than 750, about which time Ravenna lost its importance, and ceased to be considered as the capital of Italy.

It may not be out of place to insert the dates, of the principal buildings at Ravenna, built before the seventh century:—

The Duomo, of the fourth century.	
Sta. Agata Maggiore, completed	A.D. 417
S. Giovanni della Sagra, built by Galla Placidia	425
S. Francesco, time of Galla Placidia	492 to 526
S. Apollinare Nuovo, time of Theodoric	493 to 525
S. Michele in Affricesco	(?) 530
S. Vitale	534
S. Apollinare in Classe, built by order of Justinian, and consecrated by the archbishop Maximian, in	549

Although possessing square campanili,—for instance, that of S. Giovanni Evangelista (of the fifth century?), with articulations of white and green mosaics,— yet Ravenna presents


S. Giovanni Evangelista, Ravenna.


S Giovanni Battista, Ravenna.

others, which, like S. Apollinare Nuovo and S. Giovanni Battista, are cylindrical in form, a feature in Italy peculiar to the campanili of this city, and which may very probably have arisen from its connexion with the seat of government in the East; indeed, the church of S. Vitale is recorded to have been built from designs furnished from Constantinople.


S. Apollinare, Ravenna.

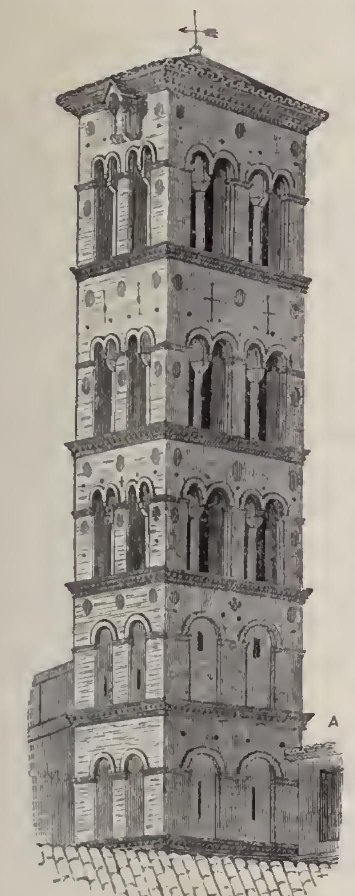
The campanili of Ravenna have all semicircular-headed openings, of precisely the same character as those of Sta. Maria in Cosmedin, at Rome, see Plate 15.

Having thus sought, by means of the campanili of Ravenna, to establish approximatively the era of the earlier buildings of this class, it will not be difficult to give instances with more exact dates, tracing them through the various stages of that Art which began its revival under Charlemagne, 768-814, was continued by the Pisans, and rapidly spread throughout Italy.

Of the early campanili, may be cited that adjoining the church of S. Giorgio in Velabro, at Rome, and partly attached to the Arch of the Goldsmiths: it was built by Pope Zacharias, A.D. 741 to 752; and, "it merits attention, because it is of a style very common in Rome, and its date well ascertained."—Woods (*Letters, etc.*).

On the columns of the temple of Mars Ultor at Rome, there is a tower, which is supposed to be of the ninth century. Among

other examples of a similar style, at Rome, are the following:—Sta. Maria, in Cosmedin, of which, as already stated, very ample illustrations are given in plate 15 (the church is of the date of 922); Sta. Croce di Gerusalemme; SS. Giovanni e Paolo; Sta. Clementina; S. Giovanni Laterano; S. Lorenzo in Lucina; S. Silvestro in Capite; Sta. Francesca Romana (a very fine specimen); S. Parenziano; the Basilica of S. Lorenzo (a small example); and, in the papal states, that of Sta. Scolastica, at Subiaco; all of the same character, and probably of the same age. They are all square towers of brick, the lower part plain, and the upper stories marked by string courses; each story has a greater or less number of small arches, with or without single columns as divisions, for windows. Medallions, sometimes of different kinds of marbles, as porphyry and serpentine, sometimes of terra cotta, ordinarily coloured bluish-green and glazed, are let into the walls of these towers as ornaments; and at the summit, immediately under the eaves, there is frequently a corbelled projecting canopy, with a niche for an image of the Virgin; a low roof completes the design.



Sta. Francesca Romana, Rome. (A, marks half the height from the ground.)

After the campanili of Rome and Ravenna, those may next be noticed of the north of Italy. These present a considerable difference in architectural character. They are more marked by the vertical paneling; the string courses, usually flat, are very secondary features; the arcades are not perforated to the same extent; and the cushion capital is not used.

Out of the papal states, the campanili attached to the church of S. Michele, at Pavia (sixth to eighth century), with those in Murano and Torcello, may be quoted as Lombard works; and perhaps, also, that of S. Miniato, which was of great use to the Florentines, in the sieges of their city, as affording them the means of watching the movements of the assailants. It is of this tower that the story is told, which assigns to Michel Agnolo the credit of suspending woollen mattresses from the projecting cornices of the campanile, to intercept the heavy stone bullets which were being constantly thrown at it. The success is intimated, to visitors, by the heaps of balls remaining at the base of the building.

Four towers of principal reputation, deserve, also, honourable notice: they are those of S. Frediano, at Lucca, date about 1100, although heavy, yet very fine; of the cathedrals of Parma (brick), Piacenza (brick), and of Pietra Santa, which is called from its size a duomo, though not so, in real rank.

The campanile of the duomo at Siena was built about 1100, by the Bisdomini, and is consequently more ancient than the cathedral. The marble coating, and all its ornaments, are by Agostino and Angelo da Siena. It has some resemblance to that of S. Zenone, at Verona, begun by Abbot Albergio in 1045, and finished in 1178, which is entirely of brick. (Plate 26.)

At Ravenna, the campanile of Sta. Maria in Porta fuori, dates between the years 1110 and 1119: its base is supposed to be the remains of the ancient square pharos of the harbour. Similarly, the belfry of S. Maurizio Maggiore, at Milan, is traditionally supposed to have been one of the three hundred Roman towers which defended the city, and to have served as a prison for saints and martyrs; while a more modest claim is put forward, for the date of the campanile of the church at Villanuova (1250), between Verona and Vicenza: this has formerly been the feudal tower, part of the castle of the San Bonifazii; so, in like manner, just out of Vicenza, near the Porta del Consilio, the march-tower, between Lombardy and the Venetian States, has been metamorphosed into the belfry of a church.

The tower on the piazza at Venice (the foundations of which were laid in 889, and the present walls begun in 1148, by an Architect named Buono), is three hundred and fifty feet high; but the arches in the upper part, with the story above them, and the spire, are said not to have been completed until 1517, under the design of another, his namesake, Bartolomeo Buono, of Bergamo.

At Este, the campanile, of high Romanesque antiquity, inclines as much as that of Pisa.

The campanile of the church Sta. Maria della Pieve, at Arezzo, is attributed to Marchione; yet this curious work, of five stories of columns, agreeing with his fantastic decoration of the façade of the church, is given by Milizia (*Lives, etc.*) to an Architect of the year 1300.

The campanile of Pisa, one of the four great belfries of Italy, was commenced by Gulielmo or Willelmus, an Architect of Innspruck, and Bonano, of Pisa, in 1174; and completed, by the addition of the eighth story, after 1345, by Tomaso, also a Pisan.

This is more usually called the "leaning tower": but this name does not convey a real notion of the bearing and form of the building. It is *not a leaning* tower, but a *contorted* or *twisted* tower. Like a tree, which, springing out of the shelving side of a rock, strives to become perpendicular, and bends its trunk by the force of vegetation—so similarly have the Architects, as they proceeded in the work, after the first sinking, endeavoured to right the building. The consequence has been, an irregular curvature in this great trunk, and an irregular connexion, of this irregular curvature, with straight lines, which no perspective view can represent satisfactorily, and which could not be shewn in a model, without the greatest attention and nicety.

This edifice is of marble, one hundred and seventy-seven feet ten inches in height, circular on the plan, and surrounded by two hundred columns, having arches instead of an entablature over the capitals. Its great renown has been earned, not by its beauty of design, nor rarity of material; but by a singular inclination of fifteen feet out of the perpendicular. Whilst constructing it, the Architects were not careful to sufficiently secure by piles, the foundation or ground-work; for before it was half completed, the walls gave way, which obliged them to strengthen the foundation on the inclining side with great promptitude. The clear lower diameter is twenty-four feet, and the thickness of the wall thirteen feet five inches. The upper diameter is twenty-five feet five inches, and the thickness of the wall nine feet. The lower or basement story, on the outside, has fifteen half columns attached to the wall: there are some slight ornaments inserted with mosaics, and a few sculptures. Above, are six stories, each formed by a peristyle of thirty columns, with a walk around, between them and the wall; and above these, another, which contains the seven heavy bells: making altogether eight ranges of columns, one above the other, including the ground story. There is a staircase of two hundred and ninety-three steps contrived in the thickness of the wall; and the interior is without floors, except one between the seventh and eighth stories. Almost all the towers of Pisa, as well as many level lines and supports of the cathedral; also the Observatory, erected in 1755, incline towards the south, in the direction of the Anio, the soil there being the weakest.

The campanile not only leans, but has sunk down altogether into the ground. The foundations appear to have cut into a vein of quicksand; and it has sunk so much, that the base could not be seen, were it not for the excavation around it. Standing inside the tower, and before the open doorway, a singular optical delusion is produced: the inclined jambs of the doorway seem perpendicular, while the perpendicular columns and windows of the duomo, seen through, seem inclined.

This has been carefully illustrated by Taylor and Cresy (*Arch. of the Middle Ages in Italy*, 4to. Lond. 1829); and very

little information has otherwise been given on the subject of this class of architectural designs, except by HOPE (*Hist. Essay*, 8vo. Lond. 1840), and H. GALLY KNIGHT (*Eccles. Arch. of Italy*, fol. Lond. 1842-44), all of which may be consulted with advantage.

At Mantua, the duomo of S. Pietro retains the fine great campanile, which is in the Lombard style, like that of the cathedral at Susa; this last is one of the finest and loftiest of its kind, and is a good instance of the effect produced by being detached from other buildings.

The tower of the cathedral at Modena, see plate 26, is one, of the four, of which Northern Italy is justly proud. Nothing of the kind is finer than the square, solid, marble pile which forms the lower part; the upper being composed of an octagon of two stories of arched openings, and the whole crowned by a pyramidal cone, which carries on its weathercock the bronze garland, from whence its name of Ghirlandina is derived. This tower is, according to GALLY KNIGHT, three hundred and fifteen feet high. The lower part, on the same authority, is said to have been completed in 1224, and the upper part, by Campione, in 1319; it is now partially defaced by some modern additions.

S. Francesco at Assisi, the most considerable church of the first Gothic period in Italy, has a campanile of Lombard character, a massy pile, with stairs *à cordoni*, commenced in 1228.

In the church of S. Antonio, at Padua, began in 1259, and finished in 1307, by Nicolo da Pisa, the campanili assume a very remarkable character. Octagonal in form, they are decorated with three stories of semicircular headed openings, and above is an upper story, with pointed arched openings; the whole crowned with a corbelled cornice and spire. These campanili more nearly resemble in form the eastern minaret, than any other work in western Europe. There must evidently have been, in the whole of this design, some strong desire to assimilate the exterior features of this building, to the model of the eastern church, as is most apparent, when the work is viewed from the east end.


Church of S. Nicolo, Pisa.

The campanile of the Benedictine abbey of S. Nicolo, at Pisa, built by the same Architect, in the beginning of the thirteenth century, is very curious and beautiful. The exterior is circular at the bottom story, the next is octagon; the third is an open loggia, surmounted by a hexagonal attic, with a high crocketed roof. It does not carry out the general form of the campanili of Italy, but is interesting, because of its well determined date, and from its being full of the character of the school to which it belongs.

Like so many other of the public buildings in Tuscany, it has been unmercifully hacked and whitewashed, almost to the extinction of its original character. The interior, which presents a winding staircase, supported by marble columns and arches, exhibits a singular degree of skill and contrivance. This structure, which is a very distant adaptation of the notion of the campanile, is a curious proof of the unsettled state of architectural feeling in Italy,—Nicolo not having introduced a single pointed arch. The staircase is important in the history of the art, for, according to Vasari, it afforded the pattern for the staircase of the Belvidere.

The six-storied campanile of the duomo at Prato, also by Nicolo da Pisa, is, in its proportions, almost as fine as that of Florence. It should be studied, since we are now beginning to appreciate these edifices, and to imitate them. It is Lombard, not Gothic; and testifies, as is usual, the entire indifference with which the two styles were contemporaneously employed.

At Florence, too, Sta. Maria Novella boasts of a fine tower with a pyramidal termination, in the Lombard style, whilst the rest of the church is Gothic, which might lead one to suppose, that after the more modern fashion arose, the older was still continued for this part of the edifice, which, with the chapter-house, was designed by Fra Giacopo da Nipuzzano.

Apparently of the same date as the cathedral, a work of the thirteenth century, is the good square tower of Carrara, having angle turrets, and a pyramidal roof. It has four stories above the roof of the cathedral, with lights in each story, progressing from one light in the lower story to four in the upper; in this arrangement of openings resembling the campanile of Siena.

The campanile of the cathedral at Bari was built in 1267.

The last work of this century, which may be quoted, is that of the cathedral of Cremona, erected in 1284; it is so undoubtedly one of the four finest in Italy, as to be called by common consent "il Torazzo"; the whole height of this magnificent tower is three hundred and ninety-five feet, two-thirds of which is given to the square part, whose proportion is six times the width of its base in height, being the same as that of the campanile by Giotto, at Florence.

This firm, square, perfect, and still fresh-looking brick tower, is divided into seven stories by string courses, the upper one with battlements and a range of intersecting arches on small columns, carried on corbels; above this rises an octagonal turret, in two stories, the upper one receding within the lower, beautifully surrounded by loggia, and surmounted by a short but graceful cone. It is constructed of two thicknesses of walls, the inner one carrying the octagon turret. The staircase, of four hundred and ninety-eight steps, is carried up between the walls in flights from angle to angle. The whole design is well worthy of careful study, and is as remarkable for lightness and elegance, as for commanding height, and bold and vigorous outline; and since the principal substance used in its construction is brick, it owes nothing of its effect either to beauty of material, or elaborate workmanship. The details are well conceived, and applied with equal judgment and taste. The skilful distribution of the openings, both as to number and width, as the stories rise in succession one above the other, and the admirable proportion of the octagon turret, with its pyramidal termination, to the square tower beneath, merit peculiar attention. It is recorded to have been erected in the short space of two years, on the occasion of the conclusion of a peace, after a long and sanguinary contest between Cremona, Milan, Brescia, and Piacenza, at the joint expense of the Guelphic partisans of the whole of the north of Italy. CIVITELLI, however, is careful to shew, that, in his time it was stated that the square part was as old as the year 754, and that the octagon was the only portion raised by the triumphant party.

The campanile of the duomo at Pistoia was originally (1301) a dungeon tower; and, it would seem, was anciently connected with some of the old municipal buildings, and it was then called the Torre del Podestà; Giovanni da Pisa adapted it to its present purpose, adding three tiers of open arches, and a pyramidal termination, the whole exhibiting much singularity. The lower part of the square tower is cased with marble in alternate courses of red and white. The brick work above is evidently unfinished. In the upper part of the square tower are openings with pointed arches; and the octagonal lantern above has semicircular arched openings on every face. Beside this fine example, there are some others of considerable interest at Verona; and the lofty campanile of the palazzo Doria, near Perugia, once a preceptory of the Templars, forming a fine feature, as seen from the roads to that city, with the belfry at Frascati, are of this date.

The tower of Sta. Chiara, at Naples, partly of the date of 1328, is remarkable, on account of the use the Neapolitan writers have made of it, in their endeavours to assert, to the detriment of the Florentines, a claim, that they were the first to introduce the use of the classic orders. This tower is said to have been commenced from the designs of Tomaso di Stefano, commonly called Masuccio, a Neapolitan, but was really by Giacomo de Sanctis, his pupil. Being decorated with the classic orders, of

very good proportion and detail, the Neapolitan authors have inferred, that it was to this artist, and not to Brunellesco (posterior to him by nearly a century), that was due the revival of classic art. But the error is evident, for the only parts of the building which are due to Massuccio, or his pupil, are the two lower stories; whilst the two upper, decorated with the Doric and Ionic orders, were not added until the beginning of the seventeenth century, according to D'Agincourt, who enters very fully upon this subject. It was finished between 1617 and 1624.


Sta. Chiara, Naples.

The fine Gothic belfry of the Basilica of S. Andrea, is still standing at Mantua, and almost without a rival in its style, except that which is the next subject of notice.

The campanile of Sta. Maria del Fiore, at Florence, in the pointed style, makes the fourth of these noble monuments, especially esteemed in Italy, and is of rich and artistic decoration (see plate 25). It was commenced by Giotto, 8th July 1334, and finished by Taddeo Gaddi. It is forty-seven feet eight inches square on plan, and two hundred and ninety-four feet seven inches high. It rises from a mass of boldly-projecting plinth moldings, admirably designed, and was intended to have been finished with a spire, one hundred and ninety feet six inches in height, but is now terminated by a fine cornice of so satisfactory a character, that it is doubtful whether this variation from the intention of the original Architect is not an improvement on his design. The tower rises in four stories of nearly equal height, the basement and topmost being the loftiest, and *diminished* from the base to the summit; the windows in the upper story are rather larger than those in the two beneath. It is partly to this disposition of the proportion of the various features of the tower that the elevation owes its beauty; for in a building whose lines are perpendicular, it is, however common the practice may be, a great mistake to diminish the proportions of the stories as they rise; the eye diminishes them fast enough, and the proportion ought to counteract this diminution. The architecture is the true Italian Gothic, uniting simplicity of outline with exuberance of ornament.

It is cased like the cathedral, with marbles of different colours, disposed in various patterns, which supply the place of the elaborate tracery and panelling of the pointed architecture of the North. The four stories of the tower, form finely vaulted chambers within, of great height; but the staircase is easily ascended. On the summit may be seen the four great piers, from which, according to Giotto's design, was to have risen the spire; so that beautiful as is the building, it is still only a fragment. The expense was enormous; it is calculated in the books of the duomo, that the average cost of each square braccio (say two feet square, reckoning the apertures as well), was one thousand florins. The particulars are collected from coæval authorities; yet, however startling in their amount, the design is worthy both of the reputation of Giotto, and of the liberality of the Republic, which commissioned him to erect a monument, which in height and workmanship should equal the most sumptuous and renowned edifices of classic times.

The lofty campanile of the Badia, at Florence, also deserves mention, as forming one of the principal ornaments of the views of that city.

The campanile of S. Gotardo, at Milan, built in 1336, is of brick, except the small stone shafts which decorate it, and is octangular in form. Of the six divisions, or stories, which constitute its height, the two upper are of less diameter than the lower ones, and are surmounted by a cone of molded brick.

The campanile of Sta. Maria de Frari, at Venice, was commenced in 1361, and finished in 1396; and at the same time and city, was built that of the church of Sta. Maria Gloriosa.

At Vicenza, is a lofty and slender campanile, near the Palazzo della Ragione, probably about the same date as the last; its height is three hundred feet, and the width of the base only about twenty feet. The lower part is square; the upper, octagonal, is crowned with a stilted dome of later date, and of the form peculiar to Venice. From the top of the cupoletta to the ground, precisely half the height, is shewn in the accompanying vignette.


Near the Sala della Ragione, Vicenza.

This is, however, not one of the campanili strictly so called; it is rather a watch-tower than a belfry; and it would seem to be only accidentally that a bell of any considerable size was hung therein. In this it resembles that at Verona, in the Piazza dei Signori, overlooking the Piazza dell' Erbe, which is still more massy, and of greater height (see plate 26). These, however, belong to the distinct class of military towers.

At the back of the church of S. Giustina, at Padua, is a handsome square campanile, terminated by an octagonal lantern, the whole of very slender proportions. That part of the road from Florence to Milan and Turin, which lies between Sarzana and Genoa, is perhaps the most interesting in all Italy, to the traveller who is curious in these buildings; those of Recco and Rapallo are lofty, and the latter is also especially slender, with many open stories. Cantorio, or Cantù, boasts of a campanile with projecting battlements, also wonderfully slender and tall; having been used as a beacon to correspond with the Baradello.

These productions bring the history of their design down to a comparatively modern epoch, and the several examples in Plates 1, 2, 13, and 14, the liberal contributions of Mr. John Johnson, give numerous illustrations of these buildings of the last three centuries, as varied in design as they are picturesque in form.

Those which more especially deserve mention, are at Viterbo, where Bramante built the tower of the church dedicated to the Madonna alla Quercia; at Forli, where the campanile to the church of S. Mercuriale, built about 1536 (?) is remarkable for its architecture as well as for its height; and at Bologna, where a fatal example has occurred of the results of a bell falling from its room, crushing a passenger walking through the ground floor.

In 1565, the successor of Giulio Romano, Giambatista Bertano, of Mantua, created superintendant of all the state buildings, by the Duke Gulielmo III Gonzaga, erected the church of Sta. Barbara, with the noble campanile of four orders, considered, at the time, the finest in Italy, on which is an inscription in honour of the Architect.

One of the best of Vanvitelli's productions is the campanile designed by him for the chiesa della Santa Casa at Loreto; this, which is of great height, exhibits a combination of four orders, and is crowned with an octagonal pyramid.

Amongst the campanili of most recent date, there is a remarkably fine one at Naples, having a lofty square tower in the lower portion, and octagonal above, terminated with an octagonal bulb-shaped cupola, covered with the coloured tile peculiar to Naples; altogether it is a very fine work. At Turin are one or two good examples of campanili; and, as above mentioned, there are not wanting pleasing or abundant examples in Genoa and its vicinity.

The lofty tower at Corneto is still surmounted by one of the

four statues of horses, which were found among the ruins of Tarquinii, and placed on the angles of the tower.

Perhaps there are no finer modern instances to be met with than the beautiful compositions of our countryman, Sir Christopher Wren. His works in London, of the campanili attached respectively to the churches of S. Mary-le-Bow, S. Mary Walbrook, and S. Vedast, Foster Lane, may be cited as examples of the highest merit. These compositions of Wren, will, so long as they endure, give a richness and picturesque aspect to the city of London of the seventeenth century, which the more modern parts of this metropolis still greatly require; and, upon the whole, they are probably the most original works which this country has produced for the last three hundred years,

In tracing the history of this class of building, we find, that the early campanili were simple towers, perforated by semicircular arched openings carried on columns, or piers, not very artistically arranged; arising abruptly from the ground without base or plinth moldings; undiminished to the summit; and divided by numerous string courses into stories of nearly equal height. Their general effect, consequently, is characteristic and picturesque, rather than elegant. One of the best instances, of this class of campanile, is that of Sta. Maria in Cosmedin. (Plate 15.)

When the pointed style from Germany travelled into Lombardy, the great country of brick, small round cylinders were employed to erect the spires; and such we see at Bologna, Cesena, Faenza, Forli, Milan, Otricoli, Parma, Pavia, Piacenza, even at the gates of Rome in Sta. Maria del Popolo, at Venice, and Verona.

As the art advanced, some very essential improvements were introduced, by giving a slight diminution to the square tower, and surmounting it with the elegant polygonal turret, which we admire in the exquisite compositions of Cremona, Modena, and numerous other towns in Lombardy and the Venetian territory; while the openings were arranged with much skill, so as to give lightness to the summit, the lower part, being left imperforated, imparted solidity to the whole composition; of which we have an example in the tower of Cremona, Plate I, well worthy of attentive study.

The main features of the campanile were still preserved by the Architects of the Revival, who, fully sensible of their extreme beauty and propriety, adopted the general ideas of their predecessors, adapting them with great skill and correctness of taste to the more refined principles of Roman architecture. The lofty square base, pierced with openings above, but solid and massive below, is sometimes as complete in itself as in the earliest cases, at others crowned by the circular and polygonal summit and dome, or occasionally, as at S. Marco at Venice, with a square tower and pyramid. The base is decorated very frequently with rustics and string courses only, or, if the orders be used as pilasters, they are of very slight projection. The Plates 1, 2, 13, and 14, will enable the reader to form a just idea of the merits of these works.

It will be scarcely necessary to point out the beauty, and propriety, of this treatment of the subject, and how superior these simple designs are, to the more elaborate compositions, which, in recent times, have been piled up with a lavish display of columns, pilasters, cornices, and pediments, in the vain attempt to produce, with the details of Roman or Grecian architecture, the outline appropriate to another style. It is also to be observed, that the Italian Architects, of the Revival, adopted the practice, invariably used by their predecessors, of placing the tower on the ground, and isolating it, as much as possible, from the main body of the church. The advantages of this arrangement are so manifest, that it is difficult to conceive why it has not been more frequently adopted in modern times (unless it be granted that too often the artist has been obliged to obey a reigning fashion), especially when it is observed how much the practice of our illustrious countryman, Sir Christopher Wren, as already noticed, coincided with that of the most approved Architects of Italy.

Before dismissing this subject, it remains only to notice two peculiarities of this interesting class of buildings—one of position, and the other of structure. First, as to position: it will almost invariably be found that they are detached, or nearly so, from the main body of the church; for neither belfries nor baptisteries were considered in earlier times as essential parts of, or embodied with, the church. Thus it is seen in Florence; in Mantua; in the duomo of the island of Murano; in Parma; in Piacenza; in Pisa; at Ravenna, in its various churches; in Susa; in S. Zenone, at Verona; and in S. Andrea, at Vercelli; and throughout every place in Italy, where the Lombard style is preserved; and where the baptistery stands near the cathedral, as at Cremona; at Florence; at Pisa; and elsewhere, the steeple makes the third distinct edifice of the sacred group. (Hope, *Essay*, p. 244.)

Its relative position varies in most of the more remarkable instances; and would therefore appear not to have been prescribed by the same rules, which regulated the distribution of the other portions of the group; that at Cremona, being placed on the north side of the western entrance, in a line with the front; that at Florence, in the same position on the south side; and that at Pisa, in an angular direction from the eastern end of the choir. Perhaps, in the majority of instances, it has been placed in the angle formed by the choir and transepts in a cruciform church, or, where there are no transepts, close to the apse at the eastern end.

Secondly, as to construction, it is noticeable, in many examples, that the walls of the base are built in two thicknesses, the staircases being carried up in flights, from angle to angle, between the two walls; or winding round on an inner shaft as a newel: there being no external buttresses, great strength and stability is evidently gained by this arrangement, which, in the instance of the leaning tower of Pisa, has no doubt tended much to preserve it, from the consequences of the very remarkable settlements which have taken place.

Finally, it may be noticed that, however much general resemblance may exist in the campanili of Italy, still there is a marked difference in various localities, partly dependant on the date of their erection, and partly from the different races by whom they were erected. The campanili at Ravenna and Rome have been described. Those of Venice, without distinct string-courses, and distinguished by the vertical panelling, as shewn in the example given at Plate 14, form another class.

The campanili with the pointed arch of Florence, are again distinct in character; and the more modern examples in the neighbourhood of Genoa (Plates 1, 2, 13, and 14), furnish another and an interesting phase.

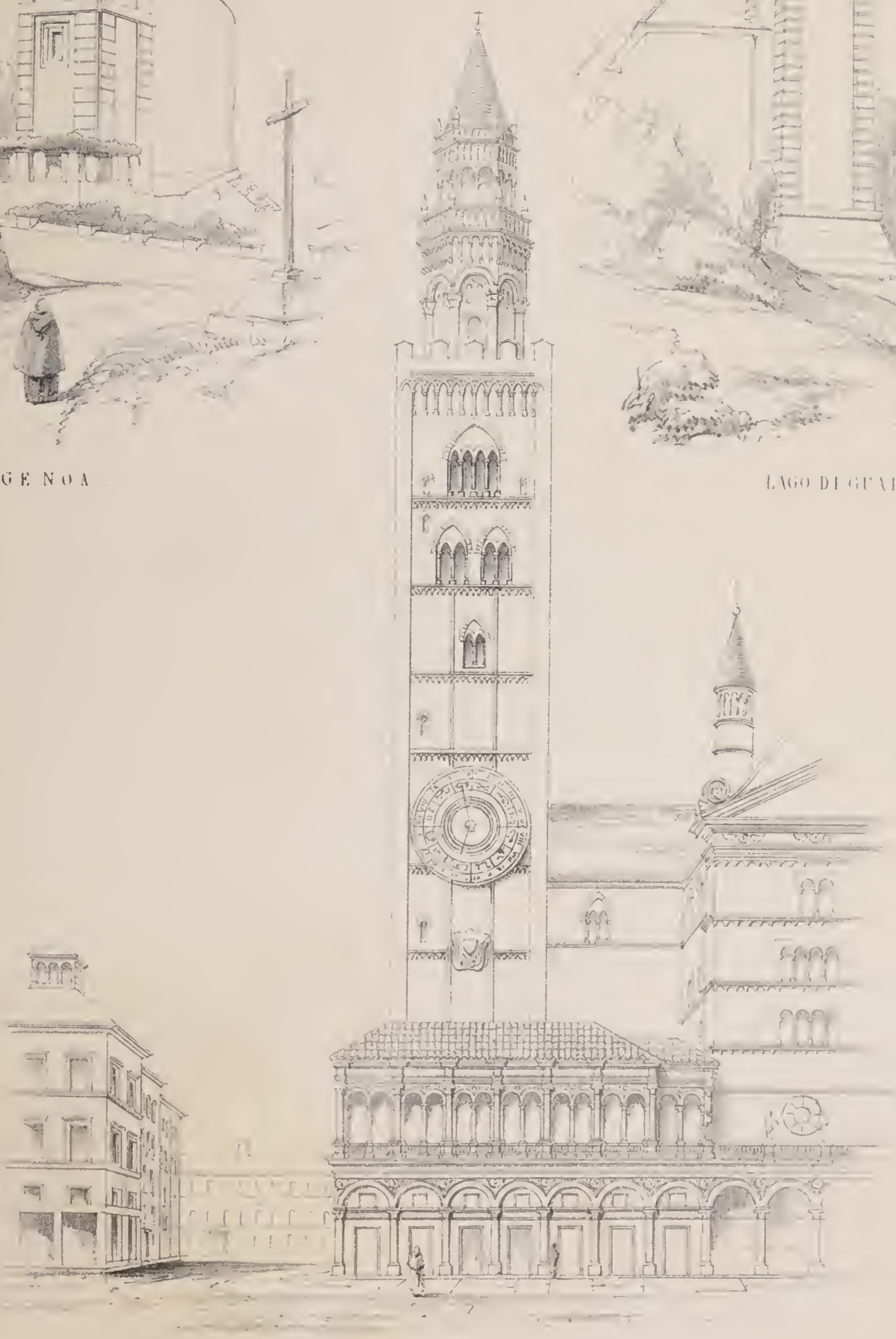
Campaniluzzo, from the same original, is the Italian diminutive of the preceding subject, applied to works of the size of the well-known turrets, placed by Bernini, on the portico of the Pantheon at Rome.

Edward I'Anson, Jun.

CAMPANILE.

GENOA.

LAGO DI GUARDA



CREMONA

R. B. Colling del.

CAMPANILE.

MOUNT CENIS

GENOA

LOMBARDY.

MESSINA

CAMPANILE.

GENOA

GIRGENTI SICILY

NEAR GENOA.

NEAR NAPLES

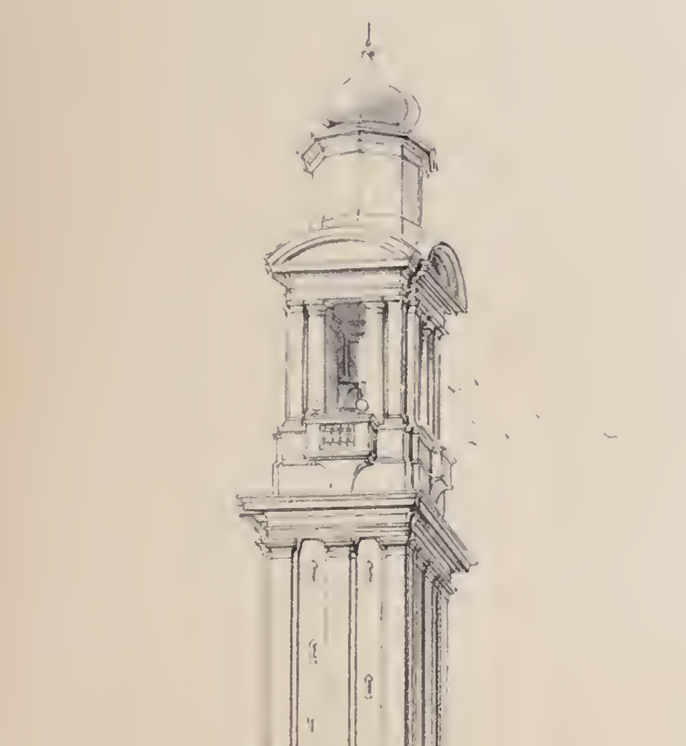
John Johnson F.S.A.

Lithographed by Messrs Day & Son May 7th 1849

CAMPANILE.

GENOA.

GENOA.

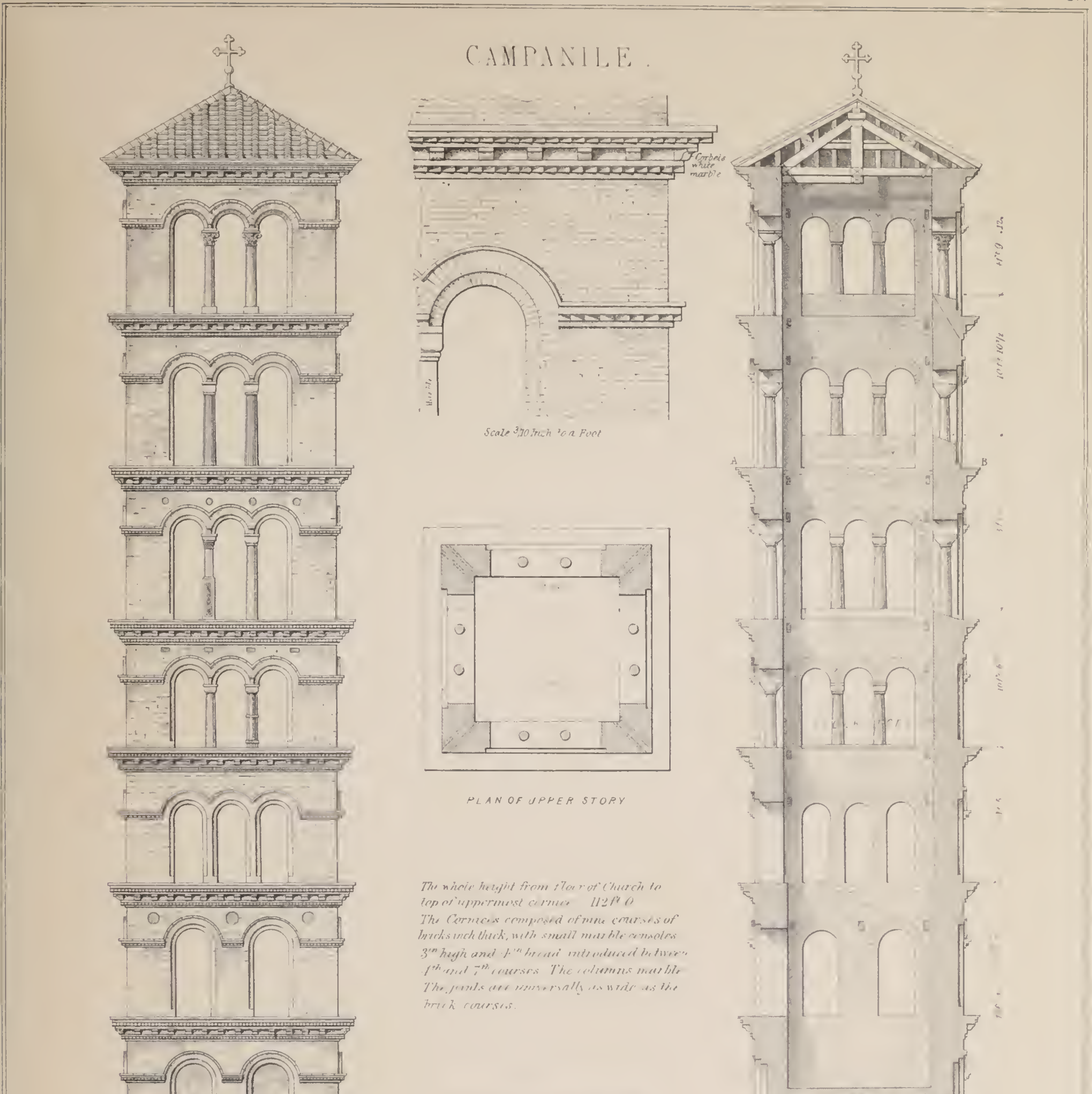


VENICE.

GENOA.

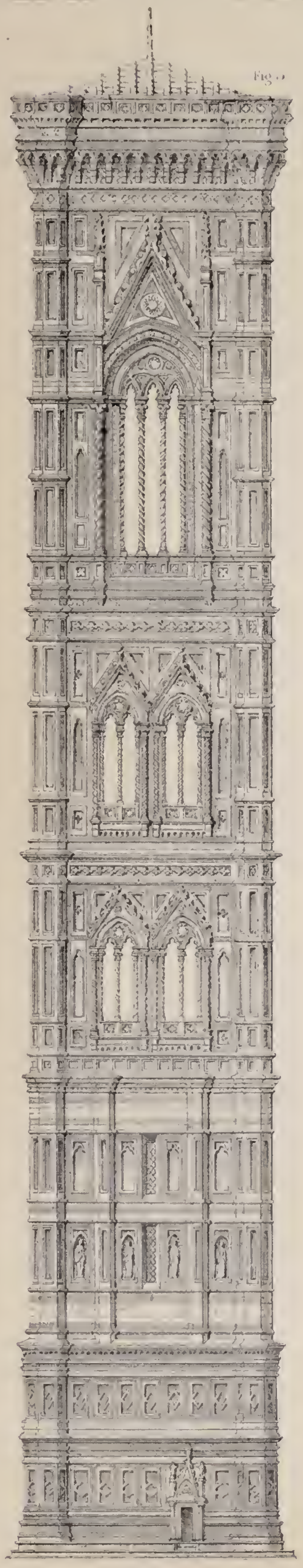
John Johnson F. S. A.

Lithographed by Mess.rs Day & Son May 7th 1849


CAMPANILE.
Corbels white marble
Scale 3/10 Inch to a Foot
A
B
PLAN OF UPPER STORY
The whole height from floor of Church to top of uppermost cornice 112 Ft. 0
The Cornices composed of nine courses of bricks inch thick, with small marble consoles 3" high and 4" broad introduced between 4th and 7th courses. The columns marble. The joints are universally as wide as the brick courses.
PLAN AT A B
St. MARIA IN COSMEDIN
BOCCA DELLA VERITÀ
ROME.
MIBA

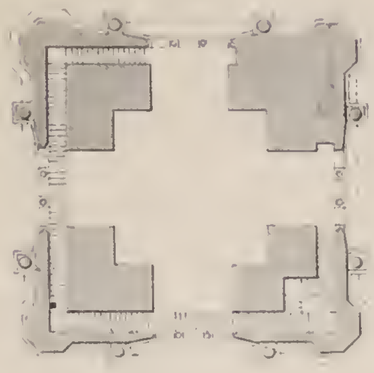
CAMPANILE.

Fig 5



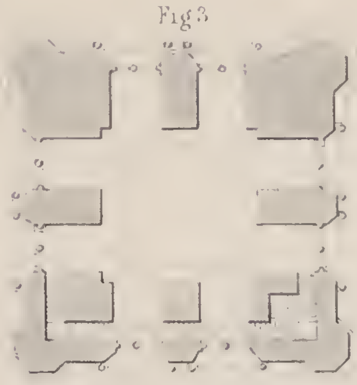
ELEVATION.

Fig 4



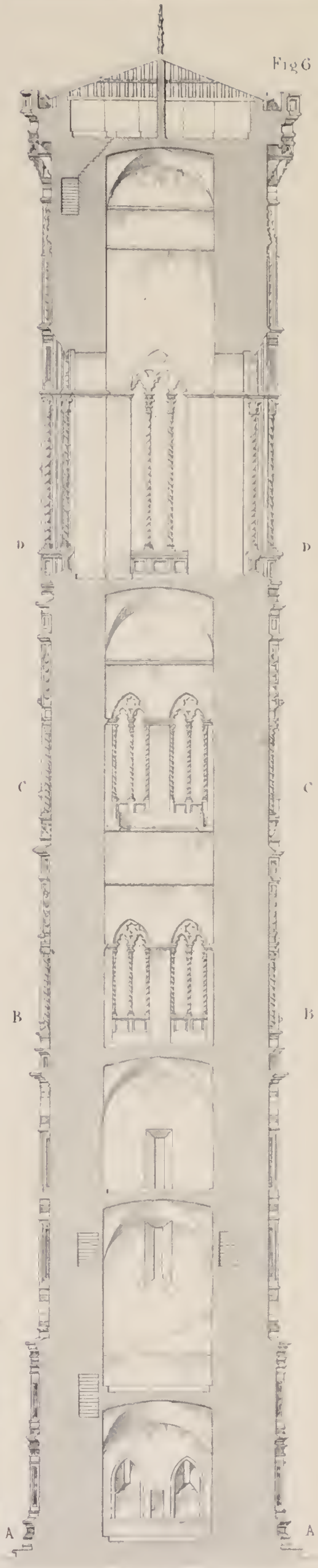
PLAN AT D D

Fig 3



PLAN AT C C.

Fig 6



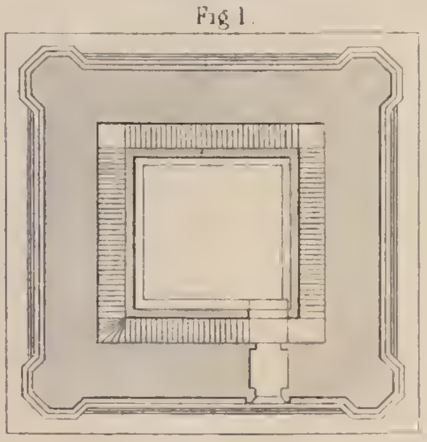
SECTION

Fig 7

CATHEDRAL OF PISINO, IN ISTRIA.

T. L. Donaldson M.I.B.A.

Fig 1.



PLAN AT A A

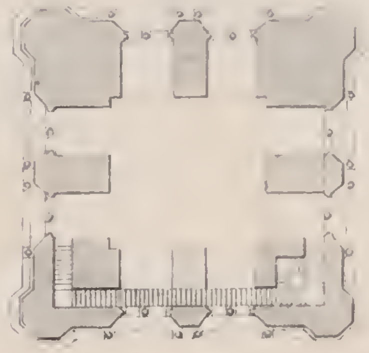
FLORENCE

CATHEDRAL of S. MARIA DE' FIORI

Giotto, Architect.

0 5 10 20 30 40 feet

Fig 2



PLAN AT B B

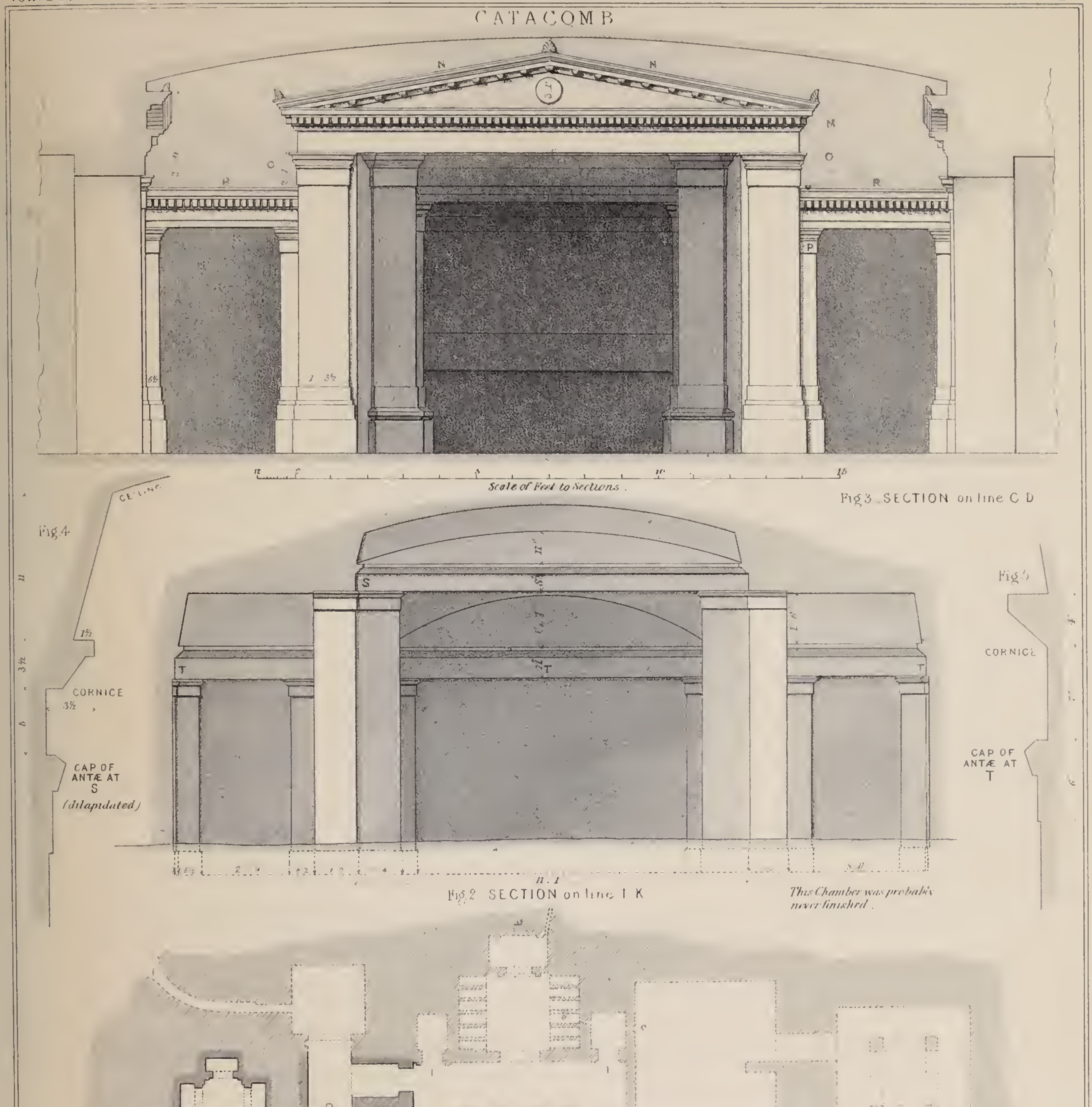
CAMPANILE.

Fig. 1.
MODENA
Cathedral

Edward I'Anson, Jun.r M.I.B.A. F.G.S.

Fig. 2.
VERONA
Piazza del Erbe

Lithographed by Mess.rs Day & Son, Jan.y 23rd 1850


CATACOMB
Scale of Feet to Sections
Fig 3_SECTION on line C D
Fig 4
CEILING
CORNICE
CAP OF ANTÆ AT S
(dilapidated)
Fig 5
CORNICE
CAP OF ANTÆ AT T
Fig 2 SECTION on line I K
This Chamber was probably never finished.
PLAN_Fig 1
Fig 6
CORNICE M
Fig 7
CORNICE R
Scale to the detail
Fig 8
CAP OF ANTÆ O
Fig 9
CAP OF ANTÆ P
Fig 10
CORNICE TO PEDIMENT N
The Sections, Detail, and the dark portion of the Plan drawn by J.J. Scoles from measurement taken with Messrs Parker & Catherwood 1823.
The lighter portion of the Plan is taken from the great French work "Description de l'Egypte"
ROCK EXCAVATIONS AT ALEXANDRIA.
Scale of Feet to Plan
J.J. Scoles. M.I.B.A.

CATACOMB.

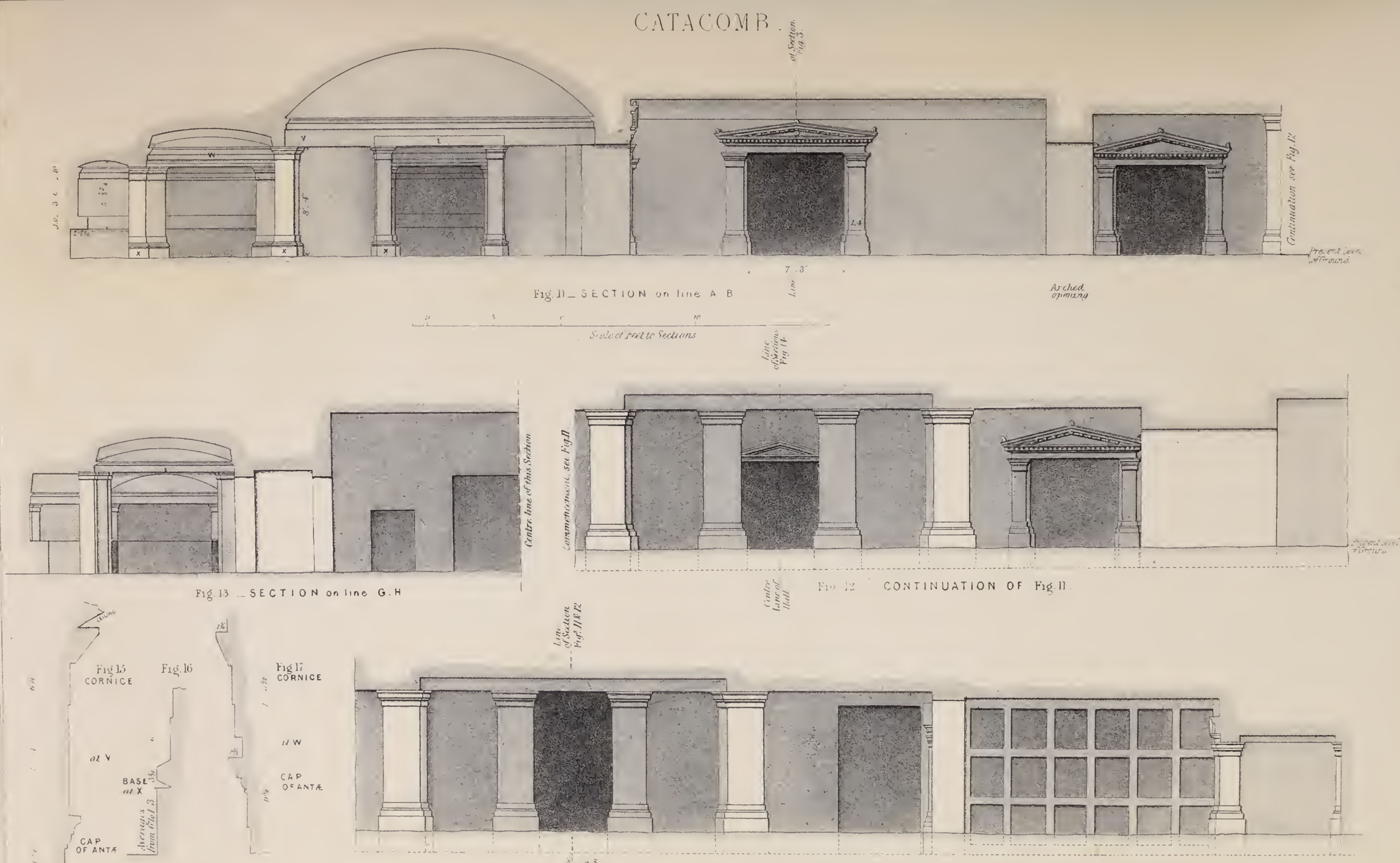


Fig. 11 — SECTION on line A B

Fig. 13 — SECTION on line G. H

Fig. 12 CONTINUATION OF Fig. 11.

DETAILS to Fig 11

Fig 14 — SECTION on line E. F.

ALEXANDRIA.

Figs 12 13 & 14 Description de l'Egypte

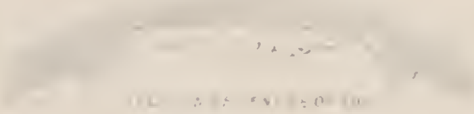
Figs 11 15 16 & 17 A. J. Scoles, M. I. B.

CEILING.

Fig. 1

VESTIBULE CHIESA GESU. ROME.

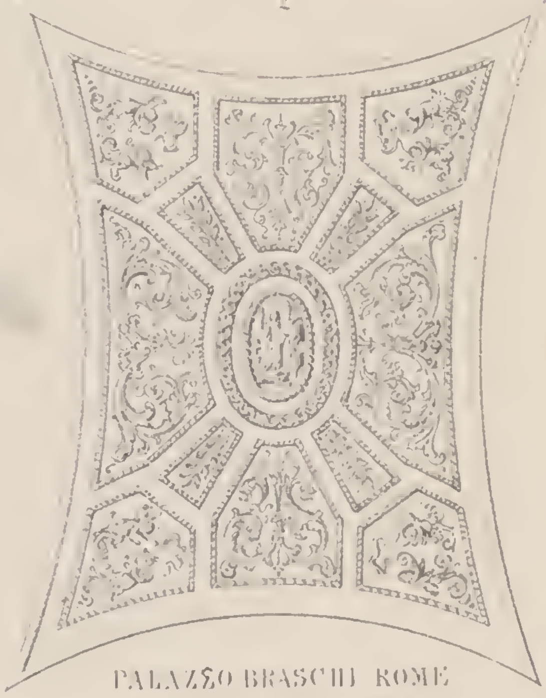
DOMED CEILING 21 FEET DIAM



3

PALAZZO BRASCHI ROME

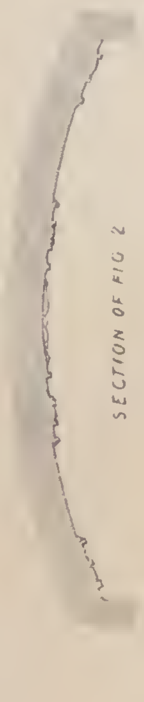
ON LANDING ABOUT 10 FT 5 IN



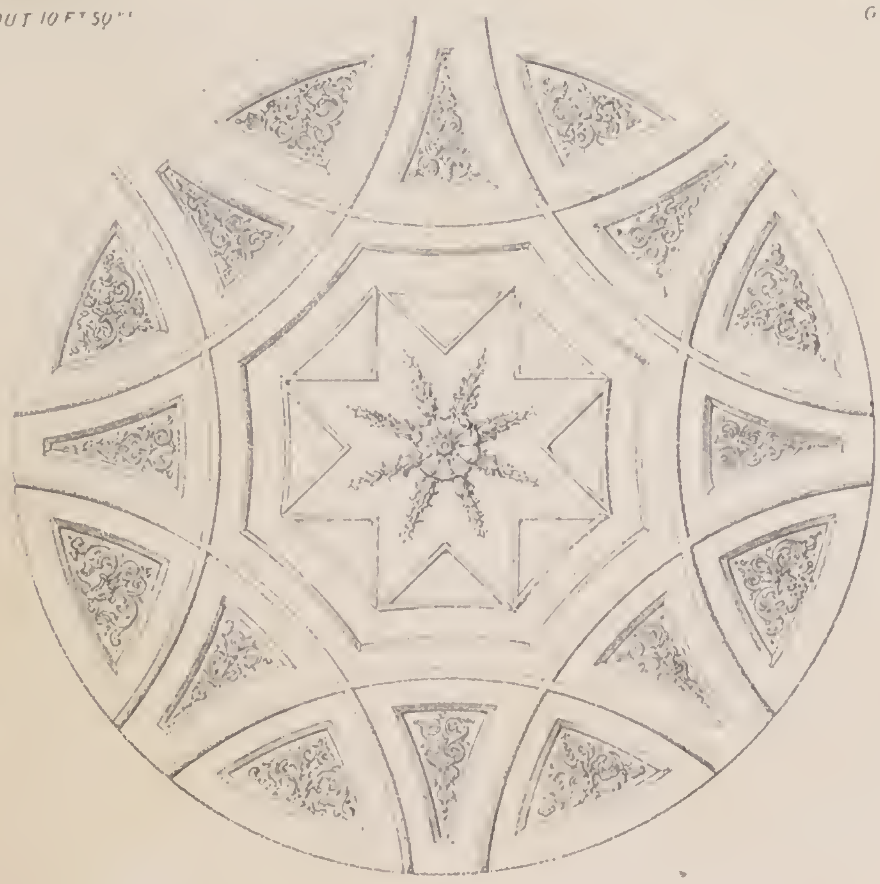
2

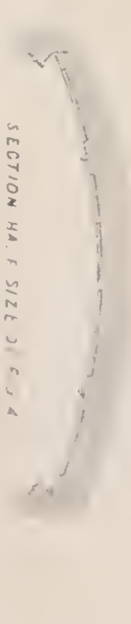
PALAZZO BRASCHI ROME

GREAT STAIRCASE 12 9 6



SECTION OF FIG 2





SECTION HALF SIZE OF FIG 4

THEATRO CANOBIANA MILAN

ROYAL BOX

CEILING.
(MOSAIC.)

VENICE.
SACRISTY OF S. MARC'S CHURCH
1517 — 1530.

Thomas H. Lewis. M.I.B.A.

... Published ... Mess^rs Day & Son. April 30th 1850

CEILING

(MOSAIC)

VENICE

CHAPEL.

CHAPEL OF S DOMENICO

CHURCH OF S DOMENICO _ BOLOGNA

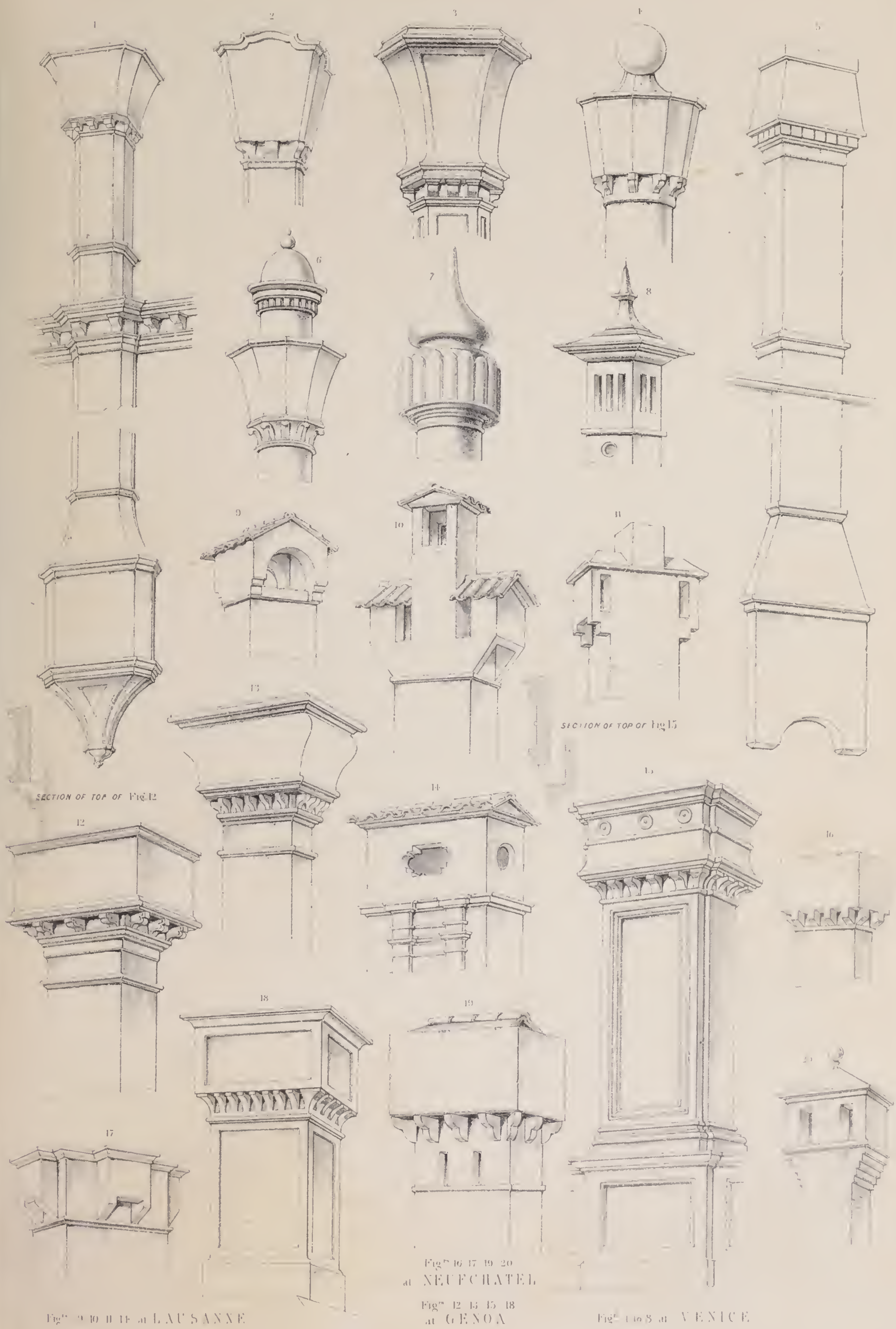
R W ... M ... I

ROME.
SS. TRINITA DE PELLEGRINI.
(PAOLO MAGGI _1614.)

T. H. Lewis, M.I.B.A.

Lithographed by Messrs Day & Son April 19th 1856

CHIMNEY.



Figs 16 17 19 20 at NEUFCHATEL

Figs 9 10 11 14 at LAUSANNE

Figs 12 13 15 18 at GENOA

Figs 1 to 8 at VENICE

CHIMNEY

Figs 1 2 3 & 10 M Digby Wyatt — Figs 4 9 11 12 & 17 R W Heneker, M I B A — Figs 5 6 7 & 15 Henry Parke in the Library of the R I B A

Figs 8 13 & 16 C Fowler Junr — Fig 14 C Wyatt Orford, Birmingham

Lithographed by Messrs Day & Son May 7th 1849

CHIMNEY.

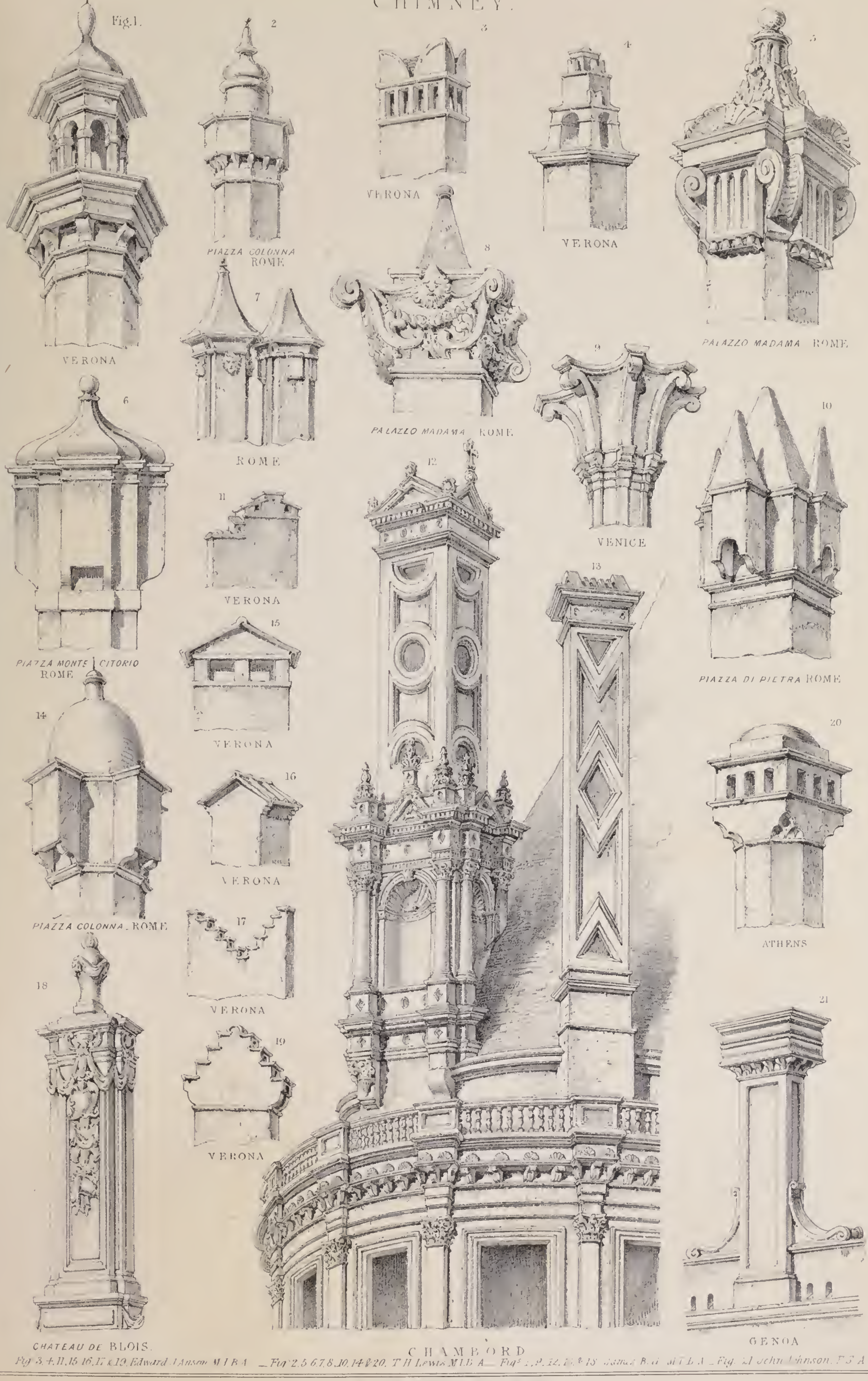


Fig. 3, 4, 11, 15, 16, 17 & 19, Edward I'Anson M.I.B.A. _ Fig^s 2, 5, 6, 7, 8, 10, 14 & 20, T. H. Lewis M.I.B.A. _ Fig^s [illegible] 9, 12, 1[illegible] & 18 [illegible] M.I.B.A. _ Fig. 21 John [illegible]hnson, F.S.A.

Lithographed by Mess^rs Day & Son April 30^th 1850

CHINESE ARCHITECTURE.

A TERRITORY of enormous extent, stretching fourteen hundred miles from east to west, and as many from north to south, peopled by above three hundred millions of persons, all living under one sovereign—preserving their customs from a period far beyond the beginning of authentic history elsewhere—civilized when Europe was sunk in barbarism—possessed many centuries before ourselves of the arts which we deem the principal triumphs of civilization, and even yet not equalled by the industry and enterprise of the west in the prodigious extent of their public works—with a huge wall of fifteen hundred miles in length, built two thousand years ago, and a canal of seven hundred, four centuries before any canal had ever been known in Europe,—the institutions of the country established for much above five-and-twenty centuries, and never changing or varying (in principle at least) during that vast period of time—the inhabitants, with all their refinement and early progress in knowledge and the arts, never passing a certain low point; so that they exhibit the only instance in the history of our species of improvement being permanently arrested in its progress,—the sight of such a country and such a nation is mightily calculated to fix the attention of the most careless observer, and to warm the fancy of the most indifferent.—LORD BROUGHAM, *Polit. Phil.*

Although many causes have prevented Europeans from becoming thoroughly acquainted with Chinese art, there are three sources from which the student may gain information sufficient to enable him to form a generally correct idea of it. He has, in the first place, the almost unanimous opinions of travellers; in the second, a knowledge of the uniformity and *esprit de routine* which characterise the works of this people; and in the third, the multiplied images of their houses and edifices, which are supplied by native artists on the various articles of ingenuity and use, which have been imported by commerce for centuries. Mr. Edward Ashworth, architect, of Exeter, having been resident in China for nearly two years, has supplied from his note-book the original and chief portion of this paper, with the accompanying illustrations; his practical experience has also revised the quotations from various authors, whose previous acquirements did not enable them to satisfy professional inquiry. The article on this subject, given by QUATREMERE DE QUINCY, *Dict. Hist. d'Architecture*, has been translated, as his authorities, although early, have been corroborated by travellers of more recent date.

The materials employed by a people in the construction of their edifices determine so naturally the measure or style of their invention and skill in the art of building, that an acquaintance with these materials is essential to the understanding and appreciation of their art.

TIMBER.

In China, trees are beams, and beams become columns, without the columns ceasing to be, or to appear beams; all the columns are of wood, and their beauty and value consist only in its quality and polish.—QUATREMERE.

There is in general a great want of timber: the oak being very scarce, the fir tree mostly supplies its place; the san wood, a tree peculiar to China, is inferior to fir. Every mountain's ridge which can possibly produce the fir is planted with it; but with the exception of the hilly districts, there are few forests in the country; for every inch of ground is arable soil. Mantchoo Tartary however abounds in primeval forests, whilst Pechele does not even produce so much timber as to make rafters for houses. In Fokiën the dwellings are of solid granite, and not a piece of wood is seen in the whole construction. There is an utter want of fuel.—GUTZLAFF.

The ly mo, or iron wood, inferior to none for strength and firmness, is used for anchors and various other purposes. Teak is not indigenous. The tse chu, cultivated in Kiangse and Szechuen, resembles the ash, and attains the height of about fifteen feet; this, with the tong chu, produces liquid gums, which are applied to woods as varnish; the former is most esteemed, as it will take any colour; the latter is boiled with litharge to make it fit for use, and seems to be chiefly applied to the floors of the apartments of the emperor and grandees.

Amongst all the plants which China produces, none is so extensively used as the tchou tse, or bamboo, called chok in Canton; every particle of this reed is converted to some use; cottages are built of it, also railings, vessels, boxes, chairs—in fact, all sorts of furniture; and paper is also manufactured from the young stunts.

No idea of these bamboos, or of their use in building, can be gained from the specimens imported into Europe. In China, their shoots attain the height of an ordinary tree; and though this cane is knotty and hollow, it is capable of sustaining great weight, and in some places, even carries good-sized wooden houses.

The nân mo, which supplies a very long, straight trunk, with wood similar to that of the cedar, although the two trees differ widely in their leaves, is used in the temples, palaces, and houses of state, on account of its straightness and durability; it serves for pillars, windows, gates, and beams, being employed in the exterior as well as the interior of buildings, as it is not affected by the action and variations of the atmosphere, or by insects; the natives indeed imagine that it will never decay; and consequently that whatever is formed of it will last for ever. They have, however, no other timber equal in beauty to the tse tan, also called mo wâng, "prince of woods", or rosewood, appropriated to the finest sort of joiner's and cabinet work; whatever is made of it therefore is held in great esteem. —GUTZLAFF *and* DU HALDE.

The columns and rafters used in the construction of houses are rather the bars of a light cage than the support of heavy weights,—the perpendicular beams serve less to support than to unite the cross timbers or horizontal rafters. The framework of the roof is only a light fabric of bamboos placed one

most plentiful timber in that country; and the spars are sawn by a single operator, with an implement resembling our pit-saws.—E. A.

The foundation is not very deep, and commonly consists of granite. It is a very general custom to raise a mud wall and face it with bricks; but houses of that description are soon soaked through and overthrown by gales. Brick houses are covered with thick ridges of tiles, with the convex part downwards, and the chinks by laying others athwart. The spars are round and flat: upon these they either put their bricks or square tiles, well joined with mortar, so as to admit no rain. The Chinese are a peculiar people, even in their mode of building. The hearth is one of the first parts they construct; but they forget to add a chimney.

The interior of the houses of the poor is wretched enough; and such are, by far, the majority. They consist of one room, which serves the purposes of kitchen, sleeping apartment, parlour, and stable, the floor not being paved. In the cold regions, a flue runs along the room, which serves as an oven for cooking the victuals and warming the apartment. The pigs lodge in the snuggest corners, and goats, asses, and colts, share the dwellings of their masters. Such are the hovels of the common peasantry. Richer people surround their premises with a stone wall, in the background of which the dwellinghouse and minor buildings are erected. At the entrance, one observes various flower-pots, and often artificial rocks, mountains, and gardens. The principal hall generally faces the south, and is the most ornamental part of the whole house. Along the sides, chairs are placed, and in front stands a table, behind which either the image of an idol, or some inscription, is attached to the wall, with an incense-stand before it. The walls are adorned with inscriptions, either drawn upon a lacquered plank with golden letters, or written upon paper. Behind this public hall are two doors, which lead to the side apartments and the abodes of the females. Most houses are only one story high; if two, the uppermost is inhabited by the women, who live in the most retired part. The windows are very small, and admit, of course, very little light; and glass being scarce, paper and shells are substituted.—Gutzlaff.

In the greatest part of their houses, when you are through the porch, there is a hall (say) toward the south about thirty or thirty-five feet long; behind the hall there are three or five rooms to the east and west, the middle room of which serves for an antechamber. The roof of the house is supported by pillars in the manner following: for instance, if the hall be thirty feet long, it will be at least fifteen feet broad, and then twenty-four pillars support the roof forward and the same number backward, and one at each end. Every pillar is erected on stone bases, and they support the great beams laid lengthwise upon them, and between every two pillars they place a piece of wood or beam across; upon the great beams, and on the two pillars at the ends, they lay other pieces of wood that support the bulk of the roof, after which they begin to build the walls. The pillars are commonly ten feet high. The magnificence of the houses, according to the Chinese taste, consists in the thickness of the beams and pillars, in the excellency of the wood, and in the fine carving on the gates.—Duhalde.

The interior arrangements of the houses of the upper classes are likewise uniform. According to Chambers (p. 8), they are all narrow and long; the ground floor is divided by a broad passage, which runs the whole length of it. The apartments are ranged on both sides, and consist of a saloon, or large room, for the reception of visitors, a small sleeping room, and sometimes a closet or study. Every apartment has a court and garden before it. The chief room, or saloon, is generally from eighteen to twenty-four feet long by twenty broad, paved with flags of stone, or marble of different colours. The walls are covered with matting to the height of three or four feet, the remainder with different coloured papers. Folding doors divide the saloon from the sleeping rooms. A passage at the side of this room leads to the study, which is always enclosed by walls and lit with windows. The walls generally are covered with paintings and moral sentences. Besides these apartments, the ground-floor includes the dining-room, the kitchen, the servants' room, the office or counting-house, the bath, etc., and shops facing the street. The leou, or upper story (when built), consists of several large halls that occupy the whole breadth of the house, and cover the apartments on the ground-floor. These are occasionally converted into lodging-rooms for strangers by wooden leaves or slides, which, when chambers are wanted, they fasten to the floor and ceiling, and in a few hours form any number of apartments. Some of these slides are open from the top to within four feet of the flooring; and instead of glass, the open part is filled with very thin oyster shells, sufficiently transparent to admit the light. All the windows in the Chinese buildings are made thereof.

The front of Chinese houses facing the street is either entirely plain, or employed as shops; there is no other opening than the door. The houses of the better classes have in the upper story a gallery or verandah, neatly painted and surrounded with a railing. Terraces are often built above the roofs and surrounded with breastworks. There they ascend to enjoy the cool air of the evening, to dry their clothes, or to keep watch. Such with few exceptions are the buildings over the greater part of the empire. The law does not permit them to deviate from the established rules; and any man, who might venture to erect an elegant and commodious house, would have his property confiscated and pulled down under pretence of useless waste. The streets are narrow, and generally not laid out according to any plan. A few cities however make exceptions. The houses of the villages are so much huddled together that there exists neither street nor lane. In the north, a certain number of houses are built in a square with the doors inward, to screen the dwellings against the blasts of northerly winds.

The houses are crowded with inhabitants, who must be content with a very little space. No class is remarkable for cleanliness, and the houses appear worse than stables if beasts have their abode in them. The inhabitants of the city keep their dwellings in better order; and merchants and shopkeepers excel in tastefully adorning their shops and laying out their wares; but there is nevertheless, with much show, a want of neatness in the interior of the buildings.—Gutzlaff.

The houses of the nobility and rich people, if compared with ours, do not deserve the name to be mentioned. It would be an abuse of the term to give them the name of palaces, they being nothing but a ground-floor raised something higher than common houses; the roof is neat, and the outside has several ornaments. The greater number of courts and apartments fit to lodge their domestics, make amends for their meanness and want of magnificence.

It must be acknowledged, however, that the palaces of the chief mandarins and princes, and such as are rich and powerful, are wonderful for their vast extent. They have four or five courts, with as many rows of apartments in every court. Every front has three gates, that in the middle is the largest, and both sides of it are adorned with lions of marble. Near the great gate is a place encompassed with rails finely lacquered, either red or black. On each side are two small towers, wherein are drums and other instruments of music, on which they play at different hours of the day, etc.

On the inside there immediately appears a large open place, wherein those wait who have petitions, etc., to present; on each side are small houses that serve for the officers of the tribunal to study in. Then there are three other gates that are never opened but when the mandarin ascends the tribunal,—that in the middle is very large, used only by persons of distinction; the rest enter through those on each side. After which, another large court appears, at the end whereof is a great hall, wherein the mandarin distributes justice; then succeed two halls set

apart to receive visits in, which are neat and abound with chairs and a variety of furniture. Such are generally the places where the tribunals of the great mandarins are erected.

The next court entered has another hall, much handsomer than the former, where none but particular friends are admitted. In the apartments about it, the domestics of the mandarin have their lodging. Beyond this hall is another court in which is a great gate, that shuts up the apartment of the women and children, where no man dares to enter. Everything there is neat and commodious. You may see gardens, woods, lakes, and everything that can charm the sight. Some have gone so far as to make artificial rocks and mountains, full of windings like a labyrinth; and the richer persons have little parks and ponds for fish and water-fowl.—Du Halde.

The upper story, generally appropriated to the women, is without a ceiling, therefore open to the spars and battens of the roof, which are occasionally painted; sometimes the former are inlaid with mother of pearl.

The pitch of the roofs is about an angle of twenty degrees; they are covered with two thicknesses of light-red tiles, having the concave side upwards. The joints are protected by small cover tiles, completely cased in a thick roll of lime, stiffened with chopped grass in lieu of hair. A larger roll, curved up to form a sharper point at the apex than the angle of the ridge, covers the gable. From the quantity of cement used about these roofs, they present a most dazzling white to the eye when new. In inferior houses, where the windows are mere jalousies or shutters, oblong panes of thick glass, much resembling the lights in a ship's deck, are inserted in the roof, to be available in stormy weather.

Architectural variety, which is not permitted in China to mar the simplicity of columns, seems to have exercised its sway in forming varieties of gable ends. The character of Chinese villages, as seen from a little distance, is that of houses huddled together, with but very narrow alleys between them. The walls, of blue brick, peeping above the bamboos, seem like a magnified copy of a church-yard full of the ornamented head-stones so often seen in the slate districts of England. (Figs. 1 and 2.) The breadth or frontage of town houses is calculated by the number of rows of tiles (nga harng), instead of lineal feet, each row being about ten inches wide.


Fig. 1.


Fig. 2.

Parapets sometimes screen the eaves; these are constructed with piers at intervals, not of necessity standing over the solids between the windows. The piers and the spaces between them are marked out in panels and enriched with stucco-work in a very elaborate manner. Sometimes the parapet is open (Figs. 3 and 11), with dark-green glazed porcelain patterns inserted. These compartments of open work frequently ventilate the close inner courts, of large dwelling-houses, which are divided by single brick, *i. e.*, ten-inch walls. Sometimes the screen wall is adorned on a larger scale, with mimic bamboo stanchions modelled in lime, as in the two cases shewn in the first view of Plate 1.

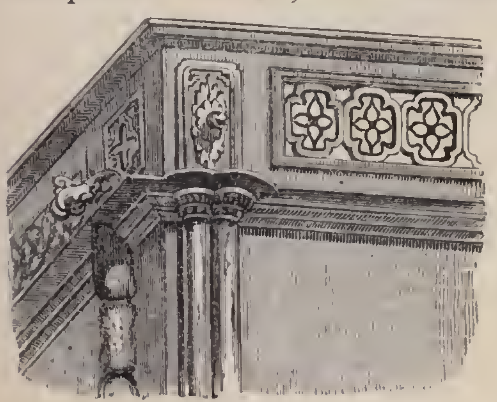


Fig. 3.

Fig. 4 completes the example of columnar decoration of wall surfaces. The coupled pillars are attached at intervals, there being one or two windows between the pairs, and they are based, not in a very solid manner, upon the string of the first floor. One section applies to these bases; the other represents the cornice and parapet, shewn in Fig. 3.

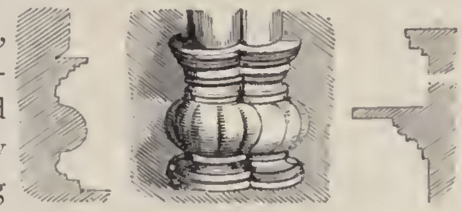


Fig. 4.

The terrace roofs are simply formed by paving tiles about fourteen inches square, laid in hard mortar upon boarding and spars.

Gutters behind parapets are often met with, formed of tile, and discharging at intervals into short stoneware pipes, "funneling" into each other to form a stack (lao yu), attached with wire to the brickwork, and stoutly cased with stucco, wrought to imitate a great bamboo; in the example, Fig. 5, from Canton, it is seven inches in diameter, and often expanding at the top in a tulip-shaped finial as a cistern head.


Fig. 5.

Sometimes the parapets are as full of holes as the bridge of a bagatelle board, and no gutter is necessary. Sometimes at the end of a long middle gutter, a gargoile, that would rival any Somersetshire tower specimen, spouts out the discharge. These uncouth animals are said to gape to a double purpose,—namely, that of swallowing evil influences when they are not disgorging drippings from eaves.

Columns in China by no means lead the fashion in architecture. Though the façades of many places of worship resemble temples "in antis", having the outer brick walls forming the sides advanced to the front of the portico (see Plate 3), the two pillars, whether square, moulded, or circular, and often granite, have no capitals, and the shaft runs up behind the carved eaves board, which turns up like a piece of drapery at the ends. This and the "antefixæ" of the rolls of the roof form the whole entablature. There is a good deal of moulding about the bases (Fig. 6), which are often pinched in as barbarously as the ladies' feet.

The bases shewn in Fig. 6 are of granite, used for internal pillars of temples at Canton. The shaft is sometimes of pine wood, and rarely more than twelve or fifteen inches in diameter.

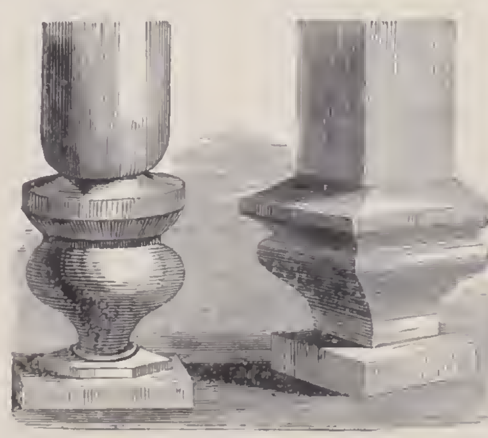


Fig. 6.

The want of a capital is partly compensated for by a bracket, composed of a meander or fret, and which in wood-work

spreads from the column under the rail of the frieze of a verandah, and is generally painted a deep green with red edges, and varnished, and sometimes studded with roses gilt or painted (see Plate 2).

Chimneys in the poorer houses are merely traps of tiling propped a foot or two above the general surface. Superior dwellings have fanciful pots covered on the top, and something resembling those common in Italy.

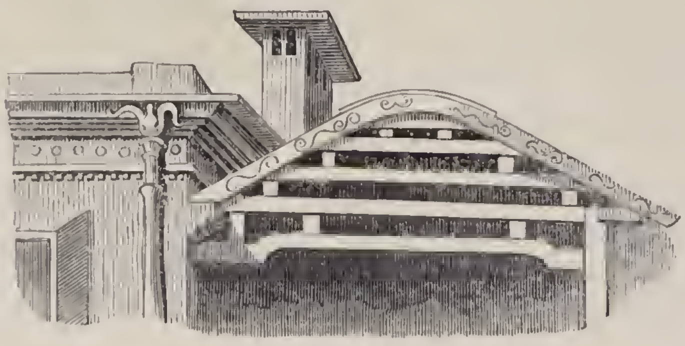


Fig. 7.

In Fig. 7 is represented a verandah attached to the flat terrace roof of part of a dwelling-house at Canton. The residence, although built for foreigners (Parsees), is of Chinese invention as to its ornaments.

Having commenced (as surveyors do) with the roofs, the carpentry will now be described, and this is decidedly the weak point in Chinese building.

Though frequent brick walls run up in all divisions of the building to take the bearings, it sometimes happens that large areas have to be covered, such as warehouses, where the clear width may be from sixty to eighty feet (Plate 6, Fig. 1). In this case, the trusses are assisted with brick piers, and there is no departure from the uncouth round spar construction. Great labour is directed to getting the ends of the little puncheons or posts accurately scribed to the convexity of the horizontal spar, leaving a little fragile tenon about an inch square as a joggle (Plate 6, Fig. 5).

The carpenters infinitely prefer their own elaborate, though faulty constructions of round poles, to the simple European king and queen post trusses, of sawn timber, which they are able to frame in one-fourth of the time occupied in putting together their own invention.

Floors are formed of the universal sappy pine spars, rarely more than ten inches thick, and if the bearing be fifteen or sixteen feet, the elasticity of the timbers indicates that the amusements of the inhabitants of the one-pair floor do not consist of saltatory exercises. As there is often no ceiling to either story, the floor-boards are ploughed and tongued.

Partitions for lathing and plastering are sometimes constructed, but boarded divisions to rooms are more common.

Of out-door works in carpentry, the jetties, bridges, temporary sheds, etc., cannot be called engineering works, as they are executed in a very flimsy manner with bamboos about the thickness of a man's arm, tied together with ligatures of the same material. They are stronger than would be imagined, owing to the number of their fastenings and cross bracings, which, like the innumerable little ties that confined the fabulous Gulliver to the soil of Lilliput, owe their power to their united force. But the writer has seen a bamboo bridge swept entire into the sea by a swollen water-course.

The laws of good construction are not considered to be violated in the imposition of a heavy balcony of brick, plaster mouldings, tiled floor, and earthenware open compartments upon slight bressummers and wood pillars (see Plate 3, Fig. 2).

A portion of a screen, similar to that seen in Plate 2, and represented in Fig. 10, may be described as a series of sash doors, not glazed, the central two being hinged. The more ornamental carvings are gilt, or painted some light colour, whilst the fret and frame-work are green; a white flower is painted on a small horizontal panel above and below the carving. The dimension, one foot five inches and a half in width, determines the scale.

Doors (moon) are generally simply formed of upright boards keyed at the back. The hinges are often nothing more than pivots above and below, and the lock and bolts of a very *wooden* construction. They manufacture good brass butt hinges, but the security of doors and shutters is so slight that shops in towns have to their open fronts a head and sill, pierced with mortices to receive the tapered ends of a set of poles about four inches thick, and the same distance apart. This mode of construction is explained in Plate 5, at the right-hand side. When all the poles are *in situ*, a board clamps them at the top, completes the barricade, and behind it the inmates can sleep securely with open doors. Panelled doors are occasionally made by sticking mouldings on the framing, and contriving the bottom rail to be the narrowest.

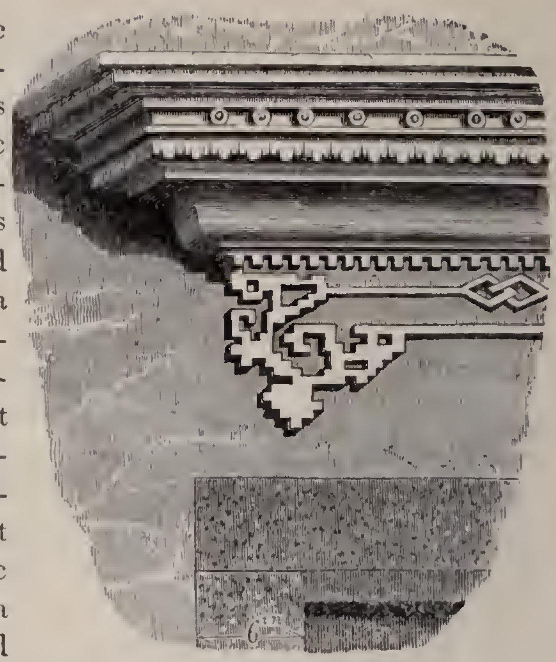


Fig. 8.

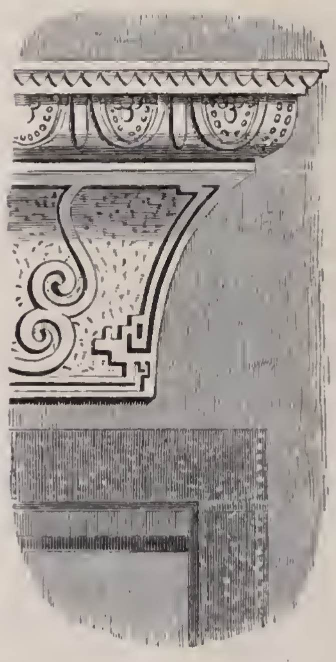


Fig. 9.

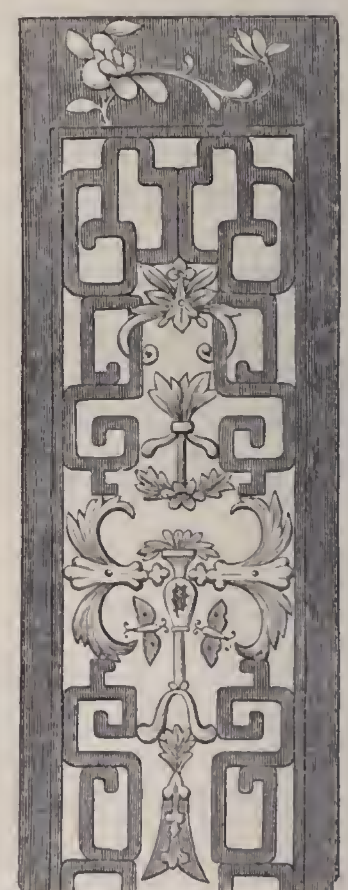


Fig. 10.

Windows (chayong moon) are light casements, often hung in rows to form an extent of sash the whole length of the front, and three or four feet in height. This arrangement applies only to the upper story, and the depth from the ranging sill to the floor is fitted with turned balusters about two inches in diameter backed with boarding. In towns, the shop-fronted houses have generally these open façades, sometimes richly carved (Plates 1 and 4).

The casements have their styles pivoted into cleats on the head and sills, having no jambs to hinge to or close against.

The windows often have cornices of plaster externally, the bedmould shorter than the architrave of the head, and finished with a tail of fret-work at each end (Figs. 8 and 9). These illustrations are taken from external examples in stucco, executed at Canton; the fret-work below the bedmould in the larger example, projects about half an inch from the face of the plastering.

There are also triangular and circular pediments to these cornices, very barbarous, and seeming to caricature the style of Inigo Jones and Christopher Wren. The first impression on a new comer is, that the natives got these from the Portuguese; be that as it may (and the question is only to be solved by the study of works erected in the interior of the country), the mouldings and the original enrichments of the tympanum are decidedly Chinese inventions.

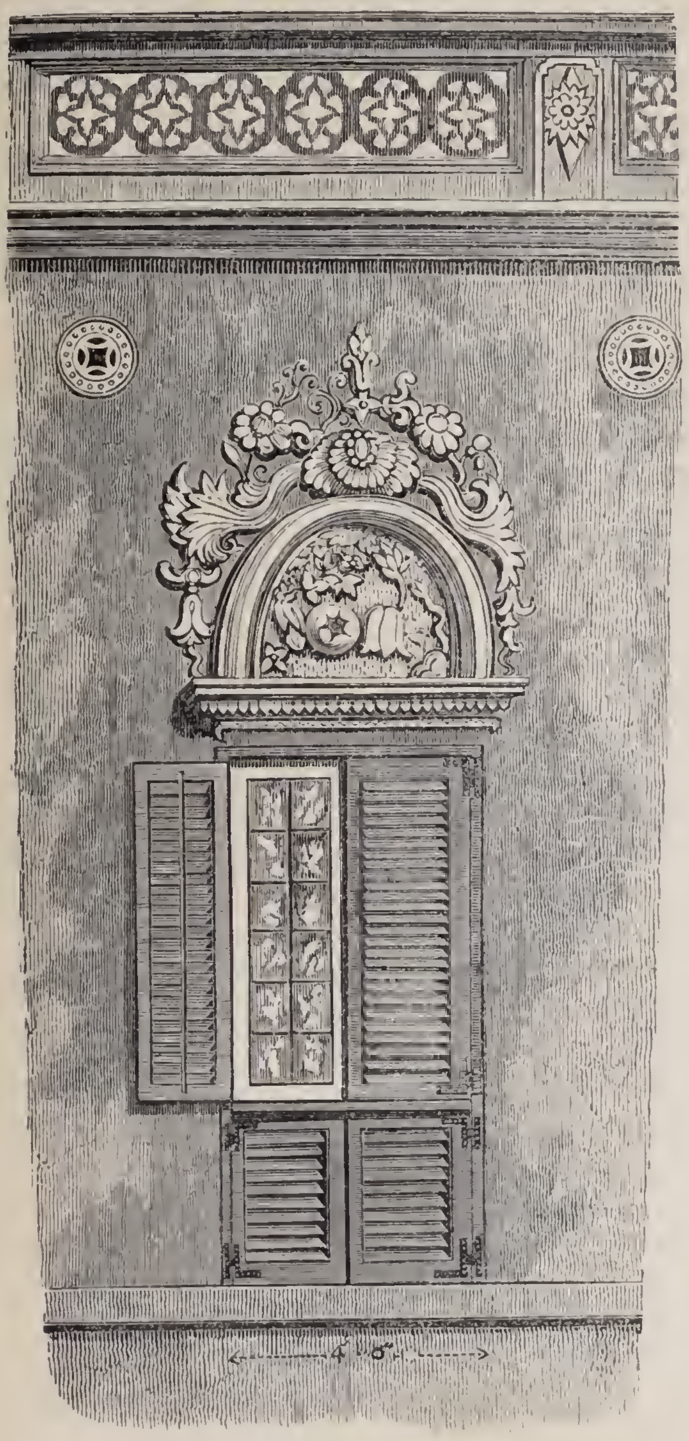


Fig. 11.

Fig. 11 is an elevation of a window from Chinam's Hong, shewn in Plate 1. The glazing is perhaps rather too civilized and conformable to English practice to be called Chinese. Fig. 12 is the same cornice and tympanum enlarged.

Fig. 12.

In well finished fronts the lower part of the sash is a panel with an embossed white sprig of leaves on the ground, which is generally green, as well as the sash-bars, that contain oyster-shell panes of varied angular figures, often disposed at random (Pl. 3, Fig. 1). A central pane larger than the rest will be filled with real glass, composed perhaps of fragments sent in casks as ballast from England, melted down and manufactured in China; while sometimes the sashes are lined with flowered paper.

In less ornamented windows closing into rebated linings in brick walls, the sash-bars which sustain the translucent shell are longitudinal only, resembling our green-house roof sashes. Basement windows, especially those of warehouses, are strongly barred with iron.

Venetian blinds (ngao park cep) sometimes take the place of the oyster-shell transparencies in ordinary houses, and are added as contrevents to those of the rich (Plate 1).

Stairs are often simple step ladders, but are sometimes constructed with rounded treads, risers, and string boards. They have also hand-rails and turned balusters. The principal defect in these conveniences is the excessive height of the riser, nine inches to eleven inches, without a compensating width of tread.

The granite, which so abounds in the neighbourhood of Canton river, is disengaged from the mass by wedges, in blocks, perhaps five feet long and fifteen inches in width and depth. This proportion causes the masonry to exhibit extremely long stretchers and small headers. Three or four courses of ashler generally form the walling of the most assailable part of a large trading house or "hong"; viz., from the ground to the sills of the lower windows, which have solid granite jambs, heads, and sills. A plinth with a good ogee moulding is sometimes introduced. The large doorways are most substantially formed of granite. Several sets of jambs and lintels, two feet wide, and nearly a foot thick, that were erecting in a mercantile house at Hong Kong, strongly reminded the writer as he viewed them of a group in Stonehenge. A bead, with an ornamental termination near the ground, adorns the angle of the door-jamb.

The upper part of the building is of blue brick, which the workman does not care to bond well together. The facing is a white stucco; cornices and strings are formed by projecting the edges of tiles one inch and a quarter thick and fifteen inches square, and these tiles too closely dictate through a thin coat of stucco the profiles of the mouldings, though ogees, cavettos, and quarter-rounds, interspersed with little enrichments, are introduced in profusion.

There are plenty of examples of brick arches in the circular apertures which in temples and dwelling-houses form openings for ingress and egress, or for ventilation. Stone mortar (shia fooi) is lime mixed with coarse grit. Brick mortar too often with red mud. Though brick facing is frequently executed very neatly, the delight of the Chinese is to plaster over the wall, wash it blue, and draw joints imitative of Flemish bond upon the coloured surface. Often in temples a long panel or frieze is sunk in the brick facing near the eaves, and its white field scattered with flowers and fruits partially gilded.

Fig. 13.

Like the people whose arts it is our province to describe, we are uniting the trades of bricklayer and plasterer. This two-branch operative possesses the accomplishments of modeller and designer of ornaments and enrichments, which are pro-

duced without working drawings. He creates cornucopiæ in circular pediments over windows, arranges sprigs of foliage in centre flowers — (Figure 13 is one about three feet in diameter for a room)—lays birds and fishes about rain pipes (see Fig. 5), executes panellings in parapets, and works up cornices

Fig. 14.

(Fig. 14) with exceeding patience by hand, rejecting straight edges and sheet-iron moulds, and all such line and rule formalities, rather crippling his mouldings however in his independence.

It is chiefly to protect these works on the exterior of a building before the plaster is well set, that an immense cage (tap pong chong) of bamboo is reared, at an expense of two hundred and fifty dollars (£53), to inclose the whole edifice. A good thatching of leaves shelters the stucco-work from the heavy rains, that would destroy in a night the work of several weeks. The setting coat of internal plastering is mixed with shreds of white paper, which supplies the place of hair: the lime sets exceedingly hard.

A remarkable feature in the ornamentation of stuccoed fronts is the introduction of ventilating apertures near the main cornice (see Fig. 11), which communicate with flues that open into the roof when there are plastered ceilings. Other ventilators pierce the slope, that connects the wall and ceiling, an inclined plane conforming to the rake of the roof, and lathed upon fearfully slender battens, which serve for ceiling joists.

Excavation goes on slowly. Earth is removed in two slender shallow baskets, carried milk-pail fashion by the labourer. In the course of the extensive building operations at Hong Kong, consequent on the conclusion of the war, in barracks, military hospitals, and fortifications, the commanding engineer, to expedite the "diggers' work", caused some barrows to be made by the carpenters of the corps of sappers and miners, such as are used by our navvies. As soon as one was brought to the scene of action, the Chinese labourers filled it with earth, and not comprehending the use of the wheel or leverage of the handles, proceeded to lift the loaded barrow upon the shoulders of one or two of the stoutest of their comrades, who were to carry it to the depositing place.—E. A.

The simplicity with which the Chinese make their scaffoldings is quite surprising; the architects of the palace employ neither beams nor planks in their construction; long poles of pine wood, which are neither touched by an axe nor pierced by a nail, and which last for several generations, suffice to make scaffolds of one hundred and one hundred and fifty feet in height; the labourers come and go as in a street, and move about without interrupting each other.—Quatremère.

The peculiar fashion of the Chinese tools in most cases proves their originality. Though their iron work is not good, yet their tools, such as chisels, planes, axes, etc., are excellent, and kept very sharp. They make great use of the circular saw, and they possess a saw for particularly fine work, which if we had not seen them using, we should have imagined the work had been done with a chisel. The blade of it consists merely of a single piece of brass wire jagged with a sharp instrument. The pattern to be cut out is traced on the wood, and a hole is bored in it, through which the wire is passed and made fast to the handle, which is kept outside the wood, and is altogether very similar to the instrument used in this country for the same kind of work.—Murray.

Their carpenter's saw is formed of a very thin plate of steel, which for this reason is kept straight by a light frame of bamboo at the back, which serves at the same time as a handle. In appearance, this has a heavy and clumsy look, but the lightness of the bamboo prevents it being so in reality. For all rough work, they make use of a sort of axe slightly rounded on one side. This answers the purpose of an adze. Carpenters work their awls with a thong, the two extremities being attached to the two ends of a stick. The thong being quite slack, a single turn of it is taken round the handle of the awl, which is then worked backwards and forwards with great velocity. The anvil of the Chinese blacksmith, instead of having a flat surface, is slightly convex or rounded. The iron that is worked upon it thus extends more easily under the hammer on all sides, but the metal probably loses something in solidity. The bellows consist of a hollow cylinder, the piston of which is so contrived that the blast shall be continuous.—Davis.

Extracts from a list of builders' prices, from an average taken at Victoria, Hong Kong, in 1845. All superficial measurements are computed in squares, ten feet by ten feet; and the dollar has been calculated at 4*s.* 2*d.* in reduction to English currency:—

	s.	*d.*
Brickwork.		
10 inches (thick) per square	39	7
14 inches ,,	60	5
18 inches ,,	79	2
24 inches ,,	98	0
Bricks, per ten thousand	150	0
Flat tiles for paving, per thousand	104	2
Plastering.		
Two coats rendering and finish stucco, per sq.	4	2
Ceiling, laths and ornaments ,,	14	7
Double tiling roofs ,,	29	2
Partitions, carpentry and lath and plaster ,,	12	6
Stonework.		
Granite, two feet thick, per square, 125 0 to	145	10
Ditto, 1 foot 6 inches thick ,, 108 4 to	125	0
Granite moulding, 6 inches high, per foot run	1	5½
Granite doorjambs, 2 feet wide, 7 or 8 inches thick, per foot run	8	4
Carpenters' and Joiners' Work.		
Hardwood, per foot cube	3	1½
Roof spars (pine), three (about 50 feet run) for	4	2
Common wood roofs and tiling, per square	41	8
Flat roof, tiling and timber, per square	104	2
China spars on hardwood girders and flooring, complete, per square	34	1
Window 8 feet by 4 feet, fitted up with French casements and Venetian blinds, in pine	66	8
The same in hardwood 81 8 to	104	2
Ordinary doors	41	8
Hardwood ditto	50	0
Painting.		
Best two-coat, per square	4	2
Best three-coat ,,	5	2½
Marble "paving tiles" 14 inches square, per 100	291	8
China (porcelain) balusters, 45 for	208	4
Inch marble floor, per square	250	0

—E. A.

GARDENS.

In Chinese landscapes we often see pretty flower gardens, but in execution they are very rarely to be found. Although the gardens are most carefully laid out, there yet appears in them little attention to elegance or pleasure; they are very few; and a Chinese grandee delights more in artificial landscapes, laid out in a small compass, than in an extensive park or a flower garden. Utility is always studied in preference to pleasure. A few pots constitute generally the whole treasure

of a rich man's house; nor are the flowers themselves so beautiful and odoriferous as those we are accustomed to see in Europe.—Gutzlaff.

Kienloong, in the province of Keangnan, and Yuenminyuen, near Peking, are the imperial gardens. The grounds of the latter are calculated to comprehend an extent of at least ten English miles in diameter, or about 60,000 acres, a great part of which however is wastes and woodlands. The general appearance of those parts near where we lodged, as to the natural surface of the country, broken into hill and dale, and diversified with wood and lawn, may be compared with Richmond Park, to which, however, they add the very great advantage of abundance of canals, rivers, and large sheets of water, whose banks, though artificial, are neither trimmed, nor shorn, nor sloped, like the glacis of a fortification, but have been thrown up with immense labour in an irregular, and as it were, fortuitous manner, so as to represent the free hand of nature. Bold rocky promontories are seen jutting into a lake, and valleys retiring, some choked with wood, others in a state of high cultivation. In particular spots, where pleasure houses or places of rest and retirement were erected, the views appeared to have been studied. The trees were not only placed according to their magnitudes, but the tints of their foliage seemed also to have been considered in the composition of the picture, which some of the landscapes might be called with great propriety. But if an opinion may be formed from those parts of them which I have seen, and I understood there is a great similarity throughout the whole, they fall very short of the fanciful and extravagant description that Sir William Chambers has given of Chinese gardening. Much, however, has been done, and nothing that I saw could be considered as an offence to nature.

PALACE.

Thirty distinct places of residence for the emperor, with all the necessary appendages of buildings to each, for lodging the several officers of state who are required to be present on court days and particular occasions, for the eunuchs, servants, and artificers, each composing a village of no inconsiderable magnitude, are said to be contained within the enclosure of these gardens. These assemblages of buildings, which they dignify with the name of palaces, are however of such a nature as to be more remarkable for their number than for their splendour or magnificence. A great proportion of the buildings consists of mean cottages. The very dwelling of the emperor, and the grand hall in which he gives audience, when divested of the gilding and the gaudy colours with which they are daubed, are little superior, and much less solid, than the barns of substantial English farmers. Their apartments are as deficient in proportion, as their construction is void of every rule and principle which we are apt to consider as essential to architecture. The principal hall of audience at Yuenminyuen stood upon a platform of granite, raised about four feet above the level of the court. A row of large wooden columns surrounding the building supported the projecting roof, and a second row, within the first and corresponding with it (the interstices between the columns being filled up with brickwork to the height of about four feet) served for the walls of the room. The upper part of these walls was a kind of lattice-work, covered over with large sheets of oiled paper, and was capable of being thrown entirely open on public occasions. The wooden columns had no capitals, and the only architrave was the horizontal beam that supported the rafters of the roof. This, in direct contradiction to the established mode in European architecture, was the uppermost member of what might be called the entablature or frieze, which was a broad screen of wood fastened between the upper part of the columns, painted with the most vivid colours of blue, red, and green, and interlarded with gilding; and the whole had network of wire stretched over it, to prevent its being defiled by birds, etc. The length of this room within was one hundred and ten feet, breadth forty-two, and height twenty feet. The ceiling was painted with circles, squares, and polygons, whimsically disposed, and loaded with a great variety of colours. The floor was paved with grey marble flag stones laid chequerwise. The throne, placed in a recess, was supported by rows of pillars, painted red like those without. It consisted entirely of wood, not unlike mahogany, the carving of which was exquisitely fine. There was very little furniture in it. In the different courts were several miserable attempts at sculpture, and some bronze figures, but all the objects were fanciful, distorted, and entirely out of nature. The only specimen of workmanship about the palace that would bear a close examination, besides the carving of the throne, was a brick wall enclosing the flower garden, which perhaps, in no respect, is exceeded by anything of the sort in England.—Barrow.

The missionaries say that the Louvre would be lost in one only of the numerous courts of this palace. This is explained by what has been already stated. If the Louvre were reduced to a ground-floor, its two other stories would suffice to make two palaces equally great. It is then in the grandeur and size of the plan that this palace surpasses European edifices. On all hands we are given to understand, that though the detached portions do not strike the eye as the choice morsels of finished European architecture, nothing elsewhere can be compared to the effect of the *tout ensemble*.

This vast extent of ground plan, either covered or enclosed by towers, galleries, porticos, and saloons, has the more striking effect from the variety of their forms, simplicity of their proportions, correspondence of their plan, and remarkable measure of unity and harmony in the several masses. It is striking to observe the gradual increase of embellishment on approaching the throne and emperor's apartments. The side courts are not to be compared to those in the centre, nor do the first entered approach in magnificence to that of the inner courts. The same graduated scale is observed in all the articles of furniture and luxury throughout.—Quatremere.

The emperor's palace at Peking, is a prodigious heap of great buildings, of vast courts and gardens. It is enclosed by a wall of brick, about twelve Chinese lys round—this wall has battlements, and is adorned with little pavilions at the angles,—over each gate there is a lofty pavilion, stronger built, and surrounded by a gallery, which is supported by pillars, and resembles a peristyle. This is properly called the palace, because this compass includes the apartments of the emperor and his family.

The space which is between the first wall, Hoang tching, and the inclosure of the palace, is above fifteen lys in circumference, and is taken up by houses which belong to particular officers of the emperor's household, or to the eunuchs, or to the various tribunals.

Although the architecture of the imperial palace is entirely different from the European, yet it strikes the eye by the grandeur and regular disposition of the apartments, and by the structure of the roofs, which have four sides, and rise very high. The whole is covered with varnished tiles of such a beautiful yellow, that at a distance they appear almost as bright as if they were gilt. Another roof, as bright as the former, springs from the walls, and ranges all round the buildings, and this is supported by a forest of beams, joists, and spars, all lacquered with gold flowers on a green ground. This second roof, with the projection of the first, make a sort of crown to these structures, which has a very fine effect. Whatever difference there may be in the goût of architecture, it is certain that these apartments, with their courts surrounded by galleries, and ranged one after the other in regular order, form an entire structure, which is extremely grand, and worthy the greatest empire of the world.

The terraces, upon which the apartments are built, contribute very much to give them that air of grandeur. They are about fifteen feet high, cased with white marble, adorned with balustrades of pretty good workmanship, and open only at the steps placed on each side, and in the middle and corners of the

front. The ascent in the middle is only a slope of marble, consisting of one or two blocks, having neither steps nor landing place. Those terraces before the windows of the apartments make a broad platform, paved with marble, which, in their length, from east to west, always projects seven or eight feet beyond the building.

The hall of the mandarins, Tai ho tien, is about one hundred and thirty feet long, and almost square; the ceiling is carved work, lacquered green, and covered with gilded dragons; the pillars, which support the roof, are about six or seven feet in circumference at the bottom, encrusted with a kind of paste, and lacquered red; the pavement is partly covered with an ordinary sort of carpet, imitating those of Turkey; the walls are destitute of all ornament, very well whited, but without tapestry, glasses, paintings, &c. The throne, which is in the midst of the hall, consists of a lofty alcove, very neat, but not magnificent. A platform extends in front, and beyond the hall northwards, having two lesser halls attached.

The court before the imperial hall is the largest in the palace, being at least three hundred feet long, by two hundred and fifty wide. Upon the gallery which surrounds it are the Emperor's magazine of all valuable goods. This gallery has five doors; one to the east, another to the west, and three to the south front. There is nothing extraordinary in this front. It has a large court before it, the descent to which is by a staircase of marble, adorned with two great lions of copper, and a balustrade of white marble; the steps are made in the shape of a horse-shoe, on the bank of a little serpentine river that runs through the palace, over which there are bridges of the same material. It would be endless to describe all the edifices of this palace; these are the most magnificent in the opinion of the Chinese and the Tartars, and are sufficient to give an idea of this work.

The palaces of the Emperor's children and other princes of the blood are very neat within, extremely capacious, and built at a great expense: the same design runs through the range of the buildings, and in the ornaments, namely, a row of courts adorned with buildings on the sides, and in front a hall lacquered and raised on a platform three or four feet high, bordered with great blocks of hewn stones, and paved with large square tiles. The doors, which generally open into some bye streets, have no other ornament than two lions of brass or white stone, of but indifferent workmanship, without any order of architecture, or any sculpture in stone, such as there generally is in the triumphal (or monumental) arches.

Of the palace of Nanking there are not the slightest remains; it having been destroyed by the Tartars in their first invasion, along with some temples, sepulchres of the Emperors, and other stately monuments.—Du Halde.

BUILDINGS.

A Tsoo tang, or hall of ancestors, exists in every considerable neighbourhood. In lieu of idols, the niches are filled with tablets to the honour of those worthies of the district, who in their life-time distinguished themselves by talent or virtue. These halls are often contained in the Wun miaou, temples of letters, dedicated to Confucius, which are as frequent as libraries ought to be in a country that has deified him, and where the catalogue of the imperial collection of books is actually printed and sold for a trifle, for the benefit of the literati, who form the first of the four castes of the people.

There is generally a tradesmen's hall in every principal city, belonging to each wealthy corporation of traders, if it may be so termed.

The embassy of 1816 observed at Kanchowfoo, a principal city of Keangsy province, that by far the most considerable buildings were the commercial halls belonging to the associated merchants and dealers. The principal room in the exchange of the green-tea merchants, who pass by this town on their way to Canton, was named Hychun tâng (Hyson Hall). In the appropriation of these edifices there is a singular combination of religious with commercial objects. They generally contain a temple of Budh or some local divinity, and at the same time are used as an exchange, or house of entertainment and lodging for the society of merchants to which they belong.

Other towns may be presumed to contain, as Canton does, a foundling hospital; a Yang tse yuen or retreat for the poor, aged, infirm, and blind people who have no friends to support them; and a Ma foong yuen, or hospital for lepers.

Canton, and indeed every other principal city, also contains a building in honour of the majesty and long life of the Emperor, under the title of Wan show koong, or hall of ten thousand years: the walls and furniture of this edifice are yellow, and at the period when the Emperor's birthday occurs in every year, the viceroy and all the principal officers of government, both civil and military, assemble there to pay him adoration. The solemnities practised are exactly the same as when he is present.

Official persons are accommodated with lodging on their journeys, in buildings called Koon kuân, or government hotels; and where these do not exist, the priests of the Budh sect are called upon to provide for them in their temples.—Davis.

TEMPLES.

There is a great difficulty in deciding upon the general form of Chinese temples, as writers have not been careful to define whether they describe an edifice of the Confucianists, Budhists, Rationalists, or even Mahometans.—E. A.

The most considerable Budhist temple in Canton is described by Chambers as occupying a large extent of ground, and containing, beside sanctuaries for the idols, apartments and other conveniences for two hundred 'bonzes', with hospitals for a great many animals, a large kitchen garden, and a burying ground, where priests and animals are promiscuously interred, both being equally honoured with monuments and inscriptions. The first object, which presents itself, is an extensive court, with a triple avenue of trees, which leads to an open (in original or covered, as given by Quatremere) vestibule, to which you ascend by a flight of steps, whence we pass on to a second, in which are four colossal figures of stucco, seated, and holding various emblems in their hands. This vestibule opens into another large court, surrounded by a colonnade and cells for the bonzes. Four pavilions are placed in it on basements. These are the temples, and consist of two stories, both filled with idols. At the four corners of the court are four other pavilions for the superior bonzes; and under the colonnades, among the cells, are four halls where idols are placed.

To the right and left of this court are two small ones, surrounded with buildings; the one contains the kitchen and the refectories, and the other the hospitals. The cells of the bonzes are of brickwork, very small, and without any other light but what comes in at the door. The principal part of the buildings are of the same material, but the columns are of wood, with marble bases. The buildings are all covered with tiles, painted green, and glazed.

The same arrangement is observed in all buildings of this kind; the only great variety consisting in the size and number of the courts.

As to the elevation of these pavilions or Tings, there is very little variety; they are generally composed of two stories. Thus, in the pagoda of Ho nang the columns of the first story are eight diameters high; their bases are one diameter. All these columns, excepting those at the angles, have, at the top of the shaft, eight consoles, or brackets, forming a very clumsy kind of capital. This ornament, though very frequent in Chinese architecture, is by no means pleasing to the eye. The diameter of the second order of columns is about four-fifths of that of the first; their height is six diameters and a half, and they are without bases. Under the second roof runs an open fret, composed of circles and squares alternately disposed. The angles of both roofs are enriched with ornaments of foliage and

grotesque figures, and on the top of the second roof are two dolphins, one at each end, with a flower in the centre, resembling a tulip.

TOWERS.

The buildings, which we call towers, have in China different names, expressing the nature of their destination.

Beside those employed in fortification, the most celebrated are the ta, or paou-ta, which the Europeans have made pagoda, attached to the Budhist temples.

At Peking one serves for an observatory; another is the choong low, or bell tower, containing a cylindrical bell of prodigious size, for announcing the five watches of the night to the inhabitants; and a pagoda was erected by the Chinese to commemorate their frustration, in 1808, of Admiral Drury's intention to reach Canton.—E. A.

In 1821, a notice was placarded at Macao, stating, that "the Chinese and foreign merchants have hitherto been prosperous, their wealth abundant, and the destinies of the place altogether felicitous. Of late, however, its fortunes have waxed lean, and the influence of the atmosphere been unlucky, so that the acquisition of riches has become less certain. A proposal is accordingly made to erect a pagoda and a pavilion, in order to renovate and improve the commercial fortunes of the island. The plan has fortunately met with the concurrence of the Portuguese magistrate, who has offered one hundred dollars to assist in its execution. Leang-ta-tsuen, whose skill is universally acknowledged, and everywhere attended by incontestable proofs, has visited Macao, in order to fix on a proper spot. He declares that a lofty pavilion should be erected on the sea-side, near the new village to the right of the temple of Ma-tsoo, and a high pagoda on the eastern arm of Monkey Island. He affirms that both prosperity and riches will be the result; that both Chinese and strangers at Macao will share in the felicity. He has written a paper on the subject, and drawn out the plan, which has obtained the consent of the Portuguese magistrate; the permission of the Chinese functionary has also been graciously given. It is therefore resolved," &c.

Lord Amherst's embassy also remarked, at Nanganfoo, a small tower erected merely for the sake of good luck.—Davis.

It seems the ta of China is not intended for sacred purposes, but erected occasionally by viceroys or rich mandarins, either for the gratification of personal vanity, or with the idea of transmitting a name to posterity, or perhaps by the magistracy merely as objects to enrich the landscape.

They are generally built of brick, and sometimes cased with porcelain, and chiefly consist of nine, though some have only seven or five stories, each having a gallery, perhaps of marble, ornamented with gilt iron rails, which may be entered from the windows, and a projecting roof, covered with tiles of a rich yellow colour, highly glazed, which receive from the sun a splendour equal to burnished gold; on each angle of the roofs a light bell is suspended, which is rung by the force of the wind, and produces a jingling not altogether unpleasant.—Alexander.

The lowest story contains an octagonal chamber, in the middle of which is the staircase; the others are similar. There is no difference in the cornices of the several stories, they are composed of a fillet and a large cavetto, enriched with ornaments representing the scales of fish. The roofs are all turned up at the angles, and all but the lowermost are adorned with little bells and foliages. The building is finished with a pole, surmounted by a ball, and around it are nine iron hoops or rings, suspended by chains, fixed to the angles of the uppermost roof.—Chambers.

These buildings are, for the most part, octangular, though some few are hexagonal and round. In height they are generally from an hundred to one hundred and fifty feet, and are situated indiscriminately on eminences or plains, or oftener in cities. Those of more ancient date are in a mutilated state, and the roofs covered with grey tiles, overgrown with moss, while others have a cornice only instead of the projecting roof.—Alexander.

Of these striking monuments of Chinese architecture, "pagodas", the one best known to Europeans stands on an island in Canton river, near Whampoa, the place where merchant ships take in their cargoes, a few miles below the city. Pachow teehoo, the pagoda of Pachow, is nine stories in height; the tapering octagon, has a white facing, with red quoins and eaves course; the roof tiles were, doubtless, originally green and red or yellow. Another, called the halfway pagoda, stands between Whampoa and Canton. Of these edifices it is recorded "that the pagoda on Pachow, and the adjacent temple, dedicated to the monsters of the sea, were built in the twenty-fifth year of Wanleih (1598); and that the pagoda at Cheihkang, and the temple then consecrated to the god of letters, were founded in the reign of Teenke (about 1621); all these structures have had a most happy influence on everything around them, causing the number of literati to be very numerous, and the productions of the soil most abundant. Recently, however, the winds and rains, driving furiously, have broken down the tops of the pagodas, and laid the temples in ruins, and injured even their foundations. Their appearance now is very unsightly; they ought to be repaired, in order to secure the return of happy and prosperous times. The pagoda on the north of the city, which rises five stories high, and has its walls painted red, a colour which from its very nature is productive of fire, ought also to be repaired, and painted with some other colour. Already we have obtained the permission of their excellencies the governor in council, to proceed with the contemplated repairs, and also recommendatory papers, in which they advise the people to assist in accomplishing this work. It being an affair which greatly concerns both our honour and prosperity, we have a right to expect, fellow-countrymen, that you will heartily cooperate, joyfully and promptly contributing, little or much according to your ability, so that by our united efforts the repairs may be soon undertaken, and the buildings rise again to their former splendour. Then, according to your deeds of merit, the gods will send prosperity, and your glory and virtue will become great beyond comprehension."—*Extract from a subscription paper, originating amongst the gentry of Canton in* 1837.

One of these towers at Keangyin, seen by the British invading forces, is described as built of red brick, each story overhanging the one below it, and thus preserving the perpendicular internally, whilst its external form is tapering. This edifice had an unfinished appearance *though* in ruins.

Perhaps a ruin near Hangchowfoo, called the tower of the thundering winds, may boast of the highest antiquity. It is supposed to have been erected 2500 years ago.

The chroniclers of the war of 1841 record the finding, at Chinkeang, of a small iron pagoda, about thirty feet in height, having each of its seven stories in a separate casting. It was ornamented on all sides with reliefs and characters a good deal defaced, and from these Mr. Gutzlaff gathers that the building must be at least 1200 years old.

These tapering towers, that so truly characterize the architecture of China, are not nearly so often met with there in reality, as in the representations upon plates and teacups in daily use in England.

A consideration of the danger and difficulty, if not impossibility, of prosecuting anything like architectural research amongst a semi-barbarous and prejudiced people, persuades us to rest contented with reprinted accounts by travellers comparatively old, and too often ill informed, or even the bare mention of the three thousand pagodas surrounding the sacred lake of Oitz, in the unsubdued isles of Japan; and of the great wall, projected by Ta che hwang, about two hundred and twenty years before the Christian era, to defend his country against Tartar inroads. The lower part of the facing of this wall is of stone, the upper of brick. The thick-

ness at the base is twenty-five feet, the core being of earth, and diminishing to fifteen feet at the top. The towers, which strengthen the wall at intervals, are forty feet square at the base, tapering to thirty feet at the summit. The parapets are furnished with embrasures, but are not thick enough to resist cannon balls.—E. A.

CITIES.

I have taken notice in another place that there is scarcely any difference between the greatest part of the cities of China, and that they are all nearly alike, so that seeing one is sufficient to give an idea of all the rest. They are for the most part square, when the situation admits of it, and surrounded with high walls, with towers built against them at proper distances. They have sometime ditches, either dry or full of water. The gates of the cities, though they are not adorned with figures in bas-reliefs like other public works, surprise very much by the prodigious height of the two pavilions that form them, by their vaults or arches that in some places are of marble, by their thickness, and by the strength of the work. Triumphal arches in the streets, tolerably handsome temples consecrated to idols, or monuments erected to the memory of the heroes of this nation, and of those who have done some important service to the state, and for the public good; in short, many public structures are more remarkable for their vast extent than for their magnificence. Add to this, some pretty large squares, long streets, some very wide, others but narrow; the houses on each side having only a ground floor, or one story higher. There are shops adorned with Chinese ware, silks, and japanned goods. Before the door of every shop there is placed a pedestal, upon this is fixed a board seven or eight feet high, either painted or gilt, on which board are written three large characters, which the tradesman chooses for the sign of his shop. There are sometimes inscribed on it two or three sorts of goods which are sold in the shop, and at the bottom the trader's name, with these words, pou hou, that is to say, that he will not cheat you. This double row of a kind of pilasters, placed at an equal distance, make a colonnade, the perspective of which is pretty enough. This, then, is in what the beauty of the Chinese cities chiefly consists.—Du Halde.

Some of the imperial palaces are laid out very tastefully, and the temples, too, often look very romantic; but to search for grandeur and classical perfection is quite out of the question. We may discover a gorgeous display of stateliness, and a pile of building chosen on a very romantic spot, an open, pleasing view, a row of low buildings following in close succession, with their dragons, painted roofs, and gilded cornices; but then we have seen all. Add to this the constant uniformity, the absence of tasteful columns and cornices, and everything else in which, according to our ideas, the excellencies of architecture consist, and we shall be able to form a just idea of the perfection of this art in China. There is not even a word in the language to express it. Nevertheless, the Chinese at Macao have built tasteful houses, and would, doubtless, be able to rear palaces, if any one would furnish them with a model, and procure for them the liberty of executing the work.—Gutzlaff.

CANALS.

The most excellent of all their works relate to the rivers and canals, which are managed with the greatest advantage to the public, insomuch that one may pass from Canton, the most southern city, to Peking, the most northern, without travelling more than one day by land, and not even that, by going a little about by the province of Quang-si and Hou-quang.

Great numbers of these works are to be seen; they are often lined on each side to the height of ten or twelve feet with fine squared free stone, and in some places with grey marble. Some of them have banks that are twenty to twenty-five feet high on each side. The great canals that are in every province discharge their waters to the right and to the left into several small ones, that afterwards form a great number of rivulets, which are dispersed in the plains, and reach to the ends of the towns, and often to the great cities.—Du Halde.

BRIDGES.

From space to space these canals are covered with a great number of bridges, of three, five, or seven arches—that in the middle is sometimes thirty-six and even forty-five feet wide, and is very high, that barks may pass through without taking down their masts—those on each side are seldom less than thirty feet, and the rest diminish in proportion towards each end of the bridge.

It was only in Keângnan that solid bridges were observed to be thrown over the canal, being constructed of coarse grey marble or a reddish granite. Some of the arches were semicircular, others the transverse section of an ellipse, and others again approached the shape of a horse shoe, or Greek omega.

Another mode of construction is by caissons of wattles filled with stones, and fixed with large perpendicular spars; over the whole were laid planks, hurdles, and gravel.—Davis.

The construction of a singular bridge is described by Barrow, page 338.

There are some of these works, that instead of arches or vaults, have three or four great stones placed on piers, in the form of planks, ten, twelve, fifteen, and eighteen feet in length, and the piers are often so narrow that the stones seem to be suspended in the air.

After having finished the arches that are next the land, when the bridge is to have only one principal arch, or raised the causeway of piers when it is to have several, they then make choice of stones of four or five feet long, and half a foot broad, which they place alternately upright and crosswise, in such a manner as to contrive that the keystone shall be laid horizontally. The top of the arch is commonly no more than the thickness of one of these stones, and because the bridges, especially when they have but one arch, are sometimes forty or fifty feet wide between the piers, and consequently, are raised very high and much above the causeway, they ascend on each side by steps of easy ascent, viz., about three inches each. There are some, that it would be difficult for horses to pass over, but the Chinese employ only porters to carry their bales, and the whole work is generally very well contrived.

Some of the fine bridges are highly ornamented. That near Peking had small pillars placed on each side, separated by cartouches of fine marble, carved with flowers, foliage, birds, etc. At the entrance to the bridge were two marble pedestals placed on each side, on which were two lions of great size with various small ones playing around them. At the other end were two marble pedestals, on which stood the figures of two children carved with some ingenuity.—Du Halde.

The Chinese have different sorts of bridges, each one having its different mode of construction, there are bridges for use, bridges for magnificence, etc.; there are, accordingly, many names employed to designate the varieties, such as lever, compass, balance, swing, bridges, etc. There are also bridges composed of pillars, placed at intervals, connected by chains of iron. The Chinese have, however, long understood the art of constructing vaults. If, in the erection of some of their bridges, they have not availed themselves of arches, others prove that it is not from ignorance. Their paintings and paper hangings, and their drawings on different pieces of furniture, are full of stone arches.—Quatremere.

FURNITURE.

The apartments of the Chinese are by no means so full of furniture as in England, and in this respect they have reached a point of luxury far short of our own. Perhaps, however, they are the only people of Asia who use chairs.

Some of the articles made for the English at Canton, could not often, in point of neatness, be surpassed in this country, and in respect to solidity are sometimes superior.

In the forms of their furniture they often affect a departure from straight and uniform lines, and adopt what might be called a regular confusion, as in the division and shelves of a book-case, or the compartments of a screen. Even in their doorways, instead of a right-angled aperture, there is often seen a complete circle, or the shape of a leaf, or of a jar. This, however, is only when there are no doors required to be shut, their absence being often supplied by hanging screens of silk and cloth, or bamboo blinds. Two or three boards, secured on forms, and a few bamboo sticks for stretching the mosquito curtains, form with a mat the ordinary bed of the Chinese.—Davis.

In adorning their rooms they are equally economical; a few pictures hung around, occasionally a mirror, and a few grotesque drawings upon a white wall, are the most common ornaments. Lackered and polished wooden chairs, some tables, a couch, some painted or lackered screens, constitute the furniture. Mud houses are beautifully pasted with paper. The floors, which generally are paved with bricks, are covered with excellent mats, or in winter with carpets or felt.—Gutzlaff.

In Chinese apartments there is placed a broad couch, in size approaching to that of a bed, called a kang; on the middle of this is planted a little table about a foot in height, intended to rest the arm or place tea cups upon; on either side of this little table, on the couch, sit the two principal persons, fronting the entrance; and from the ends of the couch, at right angles to it, descend two rows of arm-chairs for the other guests, who sit nearest the couch according to their rank. Their arm-chairs are always ranged in regular order, and being very bulky and solid, like our old-fashioned seats of former times, they are not easily removed.—Davis.

TOMBS.

Of monumental architecture there is nothing to remark, unless mention be made of an avenue of gigantic figures leading to the tombs of the kings at Nanking. The warriors cased in armour, are in two rows on each side of the road, across which large tablets of stone are extended at intervals. The ordinary burial-places are waste barren lands on the side of a hill, on which a place of sepulture is marked by a horse shoe form, three or four yards in length, being excavated, lined with walling and paved. At the deeper end is a headstone of granite with the deceased's name.—E. A.

The indigent are compelled to be content with covering the coffin with earth, which is made into a pyramidical form, between five and six feet in height, on which they plant flowers, and a species of white feathery grass.

The tombs of the mandarins and wealthy are frequently splendid, much elaborate carving being bestowed upon them; the coffin is first put into a vault, over which earth is piled to the height of twelve or fourteen feet, and nine or ten in diameter, this mass is shaped into a regular hat-like form and is plastered over with a mixture, which renders the earth impervious to rain. Around this are planted trees in pairs: first two cypress trees, then two pine trees, then two cypress trees, continuing the same round the tomb. Near the sepulchre is placed a long table or stand, made of stone or marble, and on this are placed candlesticks and jars to burn the joss sticks or incense in; on either side of the table are placed figures in pairs of men and animals, whose attitudes and expressions of their countenances betoken grief.

The finest tomb of this description is situated near Sungkiangfoo, and was erected to the memory of a mandarin of high rank; the site selected is peculiarly picturesque, the tomb being placed half way up a well wooded hill, to which access was obtained by a wide flight of stone steps. On either side of the steps were placed stone figures, most beautifully sculptured; these represented two bonzes of gigantic stature, two horses completely comparisoned for riding, two sheep, two dogs, and two cats: the effect of this extraordinary memento, placed in this picturesque spot, produces a most overpowering sensation of awe upon the mind of the beholder. Near Ningpo, a similar tomb is to be seen, but the figures are materially smaller and not so well executed, neither are the natural beauties of the surrounding scenery to be compared to the sublime prospect of the hill at Sungkiangfoo.—Sirr.

The body of a rich person is generally transported to his native province, however distant; but on the journey it is not permitted to pass through any walled town. We might take a lesson from their wholesome practice of allowing no interments within cities, and of confining them either to hills or the most barren tracts unavailable for cultivation, thus consulting at once the health and the subsistence of the living. To perform the rites at the *hills*, is synonymous with the *tombs*, in Chinese.—Davis.

PAI LOU, OR PAE FANG.

The taste for these erections, which are a species of monumental memorials, is universal in China. In the smaller towns they are built of wood; some are very large, and deserve attention; the most surprising thing about them, however, is their immense number. The Chinese annals make mention of three thousand six hundred and thirty-six erected in honour of as many individuals; captains, mandarins, princes, philosophers, all, indeed, who have rendered any service to the state, claiming a right to them.—Quatremere.

The women have their share of this honour, and they have distinguished several who have deserved and obtained the like titles of honour, and whose heroic virtues are constantly celebrated in the works of their most famous poets.

The monuments at Ningpo have generally three openings; a large one in the centre, and two small ones at the sides; hexagonal columns, or stone pillars form the jambs; the entablature is composed of three or four faces, generally without projection and moulding, except the last, or the last but one, which is in place of a frieze, of a great height, and on which some inscription is engraved. Instead of a cornice, there is a roof as a finish, which rests upon the side posts of the arches. Every gate is made in the same manner, only every part proportionally less. All these pieces, though of stone, are joined together by tenons and mortices, as if it were of wood. The later erections fall infinitely short of the old ones, demonstrating the superior skill of the ancient builders.

Upon these memorials, which are seldom above twenty or twenty-five feet high, there are figures of men, grotesque figures, flowers, buds jutting out, and other ornaments, indifferently well carved. They project so much, as to be almost separated from the work. A few of these testimonials at Ningpo are falling to pieces, being as old as the thirteenth century; the most recent ones were built in the fifteenth century.—Murray and Du Halde.

At Nankangfoo was seen a considerable number of these memorials in stone, on which the carved relief was remarkably bold, and contained representations of historical events in well-executed work. The inscriptions on some of these proved them to have existed between two and three hundred years.

Another species of memorial, of the same kind, is a large stone slab, called Shepae, being about eight feet in height, two in breadth, and half a foot in thickness, covered with inscriptions, which record some honour conferred by the Emperor, or the merit of some eminent person. These are always erected perpendicularly on the mystical figure of a tortoise, and of the same stone from which the slab is cut.

In the play of "An heir in old age", some one asks, "where are the tigers and the goats of stone?" alluding to the tombs; horses also are sometimes sculptured, life-size, as marks of esteem for particular individuals.

At Tientsin some handsome works of the sepulchral kind were described as the tombs of priests. They were constructed of excellent brickwork, and had an urn-like shape, being

narrower towards the bottom than the top, where they assumed the form of a bulb, and were surmounted with small balls. As the bodies of the Budhist priests are burnt after their death, and sometimes kept in vases in the temple, the shape of a vase or urn was sufficiently appropriate.—DAVIS.

The general features of the leading divisions of Chinese architecture, with such pictorial examples as may be required to illustrate sufficiently their peculiarities, will, of course, be found treated in the places appropriate to them in a Cyclopædia: for the present purpose, it is sufficient to indicate their names, and to give a clear idea of the impression they produce.—E. A.

ÆSTHETICS.

When a display of English military tactics had, in the year 1841, convinced the Chinese of the expediency of ceding to the "outer barbarians" an inch, when they could so easily possess themselves of an ell of the celestial country, an increased respect for the formidable foreigners, and their ready cash, engaged tribes of artisans in moulding their singular modes of constructing dwellings to the wants, wishes, and whims of Englishmen. Numbers of our countrymen had thus an opportunity afforded them of seeing buildings as they really are, and of qualifying, if not overthrowing the tent and tea-cup system, with which lexicographers have, in times past, rather misled the architectural student.

The visitor, who sails before the water frontages of Canton, will look in vain over the crowd of unpainted boats for the tasteful and symmetrical designs engraved, and often re-engraved from the drawings of CHAMBERS, and he will contrast with national pride the regular, columned, and stuccoed fronts of the Shap sarm hong (thirteen factories) with dingy wide scattered erections of faded blue brick, that constitute the citizens' dwellings of Shearngshing, the provincial city, where the upper of two stories is entirely fronted with a row of flimsy jalousies, the low pitched roof perhaps in summer protected by a clumsy veil of light boards and bamboo poles, looking as if the house had been caught in a gigantic spider's web while floating down the river. The lower story presents little prison-like apertures in gloomy walls; the front court is defended by a slight wall, ventilated with such quatrefoils as square bricks afford facilities for forming; a gate of bare poles, such as a labourer's cottage-garden in England would be ashamed to own, is set in the centre; and to this there is access by a flight of rude undressed granite steps from the swelling, muddy current of the "Pearl river".—E. A.

The customs, habits, and manners, the wants and resources, the language, sentiments and religious notions of the most ancient society, and the most populous empire existing amongst men, are, without doubt, most interesting subjects for the investigation of the philosopher, and not unworthy the attention of the statesman. But the expectations of the man of science, the artist or the naturalist, might rather perhaps be disappointed, than their curiosity be gratified in travelling through this extensive country. It can boast of few works of art, few remains of ancient grandeur. The great wall, that for a time defended its peaceable inhabitants against the attacks of the roving Tartars, the walls of its numerous cities, with their square towers and lofty gates, and here and there an old pagoda, are its only architectural antiquities; and, when these are excepted, there is not perhaps a single building in the whole extent of China that has withstood the action of three centuries. There are no ancient palaces nor other public edifices, no paintings nor pieces of sculpture to arrest the attention of the traveller, unless it might be from the novelty of their appearance. In travelling over the continent of Europe, and more especially on the classic ground of Italy and Greece, every city, mountain, river, and ruin, are rendered interesting by something on record which concerns them; the theme of some poet, the seat of some philosopher or law-giver, the scene of some memorable action, they all inspire us with the liveliest sensations, by reviving in the mind those pleasures which the study of their history afforded in early life. To Europeans, the history of China has hitherto furnished no materials for such recurrence; and the country itself is, therefore, incapable of communicating such impressions. In vain should we here look for the massy and stupendous fabrics that appear in the pyramids and the pillars of the ancient Egyptians; the beautiful and symmetrical works of art displayed in the temples of the Greeks; the grand and magnificent remains of Roman architecture; or that combination of convenience and elegance of design which characterizes the modern buildings of Europe. In China, every city is nearly the same; a quadrangular space of ground is enclosed with walls of stone, of brick, or of earth, all built upon the same plan; the houses within them of the same construction, and the streets, except the principal ones that run from gate to gate, invariably narrow. The temples are nearly all alike, of the same awkward design as the dwelling-houses, but on a larger scale; and the objects that are known in Europe by the name of pagodas are of the same inelegant kind of architecture from one extremity of the empire to the other, differing only in the number of rounds or stories, and in the materials of which they are constructed. The manners, the dress, the amusements of the people are nearly the same.—BARROW.

The first knowledge to be acquired in order to appreciate the arts of a people, is that of the spirit of the nation, or the causes which formed its customs, its manner of living, of seeing and feeling, and which from that time must have given a constant direction to all its works. The operation is the same with great and small, with the mass which we call a nation, as with the individual being.

Amongst men there is found a difference of moral faculty, which causes one only to be suitable to those professions where the routine dispenses with reflection, where the labour of the mind never runs parallel with that of the hand, and of which the whole genius lies in the instinct of one uniform repetition; whilst another has received from nature an activity of thought and imagination, which carries him into every sphere to seek and to find continually new combinations. From these two qualities with which the different nations of the earth are endowed, will result with the one in all its operations what is called the habit of stationary routine, and with the other that of necessity of advancement, which, when applied to its productions, is called perfectibility. Now these two effects will be in different countries powerfully seconded by the action of natural character on political elements, and by the reaction of political causes upon the moral faculties of the mind, and upon its operations.

Considering the point at which the arts of China have remained stationary for so many ages, the conclusion necessarily is, that either in the influence of the character of man upon political springs, or in the action of these springs upon the development of moral activity, there is a powerful cause which has at all times contributed to compress, to impoverish, and to render sterile all the germs of invention in Chinese art. If we would believe those who wish to justify China on this point, the government only regards the arts under the aspects of commerce and utility: of what importance shall we say is the opinion of the government? This defence still strengthens the judgment exercised towards the arts and architecture of this country: it may be affirmed that none has preserved more faithfully the first traces of the springings forth of primitive habitations in construction and exterior forms.

DE PAUW is quoted with applause for saying that we cannot deceive ourselves as to the object which has served as a model for their first building: they have imitated a tent. Nothing seems to render a better reason for the singular construction of their habitations, which rest upon their basis even when their walls are overturned: in fact, the walls surround the house without supporting it; they serve only as a shield to the timber

work without supporting the roof, as if from the beginning they had made a more solid enclosure of masonry around the tents to keep in the cattle. Such ought to have been of necessity, with regard to house building, the first step from the pastoral and wandering towards the sedentary life. "When one considers in general," says the above cited author, "a Chinese town, one sees that it is only, so to speak, a fixed camp."—QUATREMERE.

The usual sagacity of the accomplished lexicographer seems to have deserted him, when he allowed himself to be misled into seeking, in the habits of a savage race, for the origin of the architectural habits of their civilized progeny. Admitting, which is almost impossible, that the Chinese ever were a nomadic people, it is known that they were devoted to the pursuits of agriculture before they began to have written history, *i. e.* at least before 550 B.C., when they called the Tartars "Heungnoo" (Huns), erratic nations. It is true that the dominant race, and a large portion of the present empire, are Tartaric; but the truly Roman policy, far from attempting more than one revolution in the habits of the many, has been satisfied with political supremacy, and yields to the ancient civil, criminal, and religious codes. Thus the Budhist (imperial) faith is only tolerated, while the native Confucians are acknowledged as professors of the state religion; and no trial of the strength of a new and intrusive government has ever been considered so dangerous, as the compulsion of the Chinese, about 1650, to shave the thick hair, which their nation had been accustomed to wear from the most ancient times as a cherished ornament, and to betake themselves to the Tartar fashion of a long plaited tress or tail; the penalty of death was preferred by many to the disgrace of submission, while thousands expatriated themselves. If it be asserted that architecture also was then subjected to the influence of fashion, it only remains to appeal to the pagodas built even so little as two centuries before that time. At some future period, however, the student will take into consideration the probable effects of the Mongol invasion, in 1234, which destroyed the monuments of previous ages.

The materials, the climate, and the religion of the people are, as QUATREMERE himself admits, the guides to the architectural style of their earliest times; it is not until civilization has ensued, that their habits can be seen influencing their buildings: all archæologists are satisfied with tracing the Greek temples to the simplest erections of beams and round logs of wood; and the more varied designs of the Chinese may be resolved into the following elements of construction: two gable walls of brick or mud, terminated ornamentally without regard to the rake of the roof; and a surface of tiling, carried on a series of round spars as purlins, bedded in the gables; the back may be a solid wall; the front either open, with round wood columns to carry the roof plate, or filled with slight boarding and window blinds; or it may be a wall with a central doorway: this definition will apply to cottage, mansion, and temple.—E. A.

The admirable manner in which the use of the bamboo combines lightness with strength, renders it a most valuable resource to this ingenious and industrious people. Their theatres, their halls of reception on public occasions, and their temporary warehouses for storing goods, are erected at a few hours' notice, and serve equally to exclude the heat and the rain. They can be built of almost any height or breadth required, on account of the extreme lightness of the materials. Not a nail is used in their construction, nor even a cord; but the thin strips of the bamboo bind every part together in a perfect manner; and when the end of their erection has been answered, they are taken down and carried away with equal ease and dispatch.—DAVIS.

The idea of the tent being the prototype of Chinese edifices generally, is an assumption hardly tenable. There is sometimes, indeed, seen an octagonal edifice with the hips of its roof curved, as if in imitation of slack cords, and the tiled surface between them following the form that would be assumed by loose canvas in a similar position. The copings of gables often terminate at the apex in a curve, and the ridge crest is a canoe-shaped mass of stucco, moulded into a labyrinth of square fretwork.

The temporary buildings of the Chinese, whether erected for the performance of periodical religious ceremonies, or for the lodgings of artisans carrying on any public works, or for other purposes, are constructed in roofs and walls of a kind of thatch, on a framework of poles and sticks, in flat surfaces. The stiff matting, that is spread in segment and semicircular arches to cover boats, forming also the roofs of small cottages, is not suited to cover large tents. The above simple forms have probably been used from the earliest ages, and gradually improved upon; whilst the curvilinear features have been added as ornaments, rather than adopted as coinciding with the elementary principles of their mode of construction.—E. A.

The spirit of lightness is so imprinted on all the monuments of China, that it would be sufficient to define the origin of its house building; and this unvarying people's imitation might suffice to set us a standard, as to the lightness which constitutes the character of their architecture. Thus facts suffice to demonstrate that no shade of an opposite character could have been perceived there, since it is the very want of solidity which in that country constitutes both the foundation of the art, and the means that it makes use of. It is, therefore, very useless to seek either to accuse or excuse this architecture from being what original and inherent causes (whether from the nature of the country, or from the forms of society which has appropriated them to its wants) have forced it to be.

But there is still a characteristic quality which ought to be remarked, if not in what constitutes the fundamental principle, at least in what becomes and forms the exterior effect of Chinese architecture. This quality (more material, in fact, than intellectual) is *gaiety*. We may fairly infer, that in no other country could the art of building offer an aspect more flattering to the eye. Masses and double roofs glistening with tints, the effect of which is compared by the Chinese poets to the shadowings of the rainbow; porticoes diapered with all sorts of colours; varnished surfaces extending in all directions; the agreement of this kind of decoration with the light forms of the building; all this should present to the eye a species of gratification, the reality of which cannot be contested; and we cannot doubt, that with a critic who could only have learned to judge of works of art by material action and physical impression, the most beautiful forms, and the most regular proportions, will have less effect in fixing his attention than the brilliancy of colours.

As a quality of the art of building among the Chinese, must be recognized the agreement of its taste for ornament or decoration with its forms and composition. Nothing like that taste for ornaments in sculpture, to which the mind naturally refers when ornament is spoken of, is to be remarked in it. The art of ornamenting a Chinese building is nothing more than that which might give a notion of the art that mechanics apply to the manufacture of articles of furniture or objects of a capricious taste for luxury. In fact, they treat a building, in the department of ornament, as a cabinet. Its beauty consists in the precision of the work and its neatness; they varnish the columns, they colour the roofs, they case the walls with coloured materials; to be the most showy, the most brilliant, the most unchangeable, are the first merits of fine buildings. If figures are painted in them, the merit of the design is last considered. When they would carry to their highest pitch the richness and durability of ornaments, they use colours that fire has rendered unalterable in porcelain.

The most famous monumental edifices—the palace of the Emperor, the towers which have been mentioned—shine with the brilliancy of these substances—reserved for the honour of the gods and the sovereign.

As for the art, properly so called, of ornament in China, it is nothing more than the art of cutting open-work patterns. Thus it is in these designs that the Chinese excel: their furniture, their seats, their tables have, in this work, a charm that the inexhaustible resources of the artizan knows how to multiply to infinitude. The sashes of the windows exhibit every imaginable pattern, a fact as regards all oriental nations.

Open work designs occupy rather a considerable position in buildings; it is this that would seem to correspond to the part of our arrangement that we designate the frieze. It appears, then, that all the branches of the Chinese art of building are in complete accordance with each other. No style, no foreign taste having been permitted to mingle with theirs, this art has received its development in a manner conformable to the unchangeable wants and resources of the country and of the genius of its inhabitants.

Thus the established line of practice holds, and has held Chinese architecture for a great number of ages in a stationary existence, whence it is hardly allowable to believe it capable of emerging. Perhaps, in fact, all that in art has had time to suit itself to the uniform and few wants of an immense population, isolated by a variety of causes from all other people, seems as if it should be equal in duration with that people itself.—Quatremere.

MEMORANDA CONCERNING THE ERECTION, BY NATIVE ARTIZANS, OF AN ENGLISH HOUSE IN CHINA, DESIGNED AND SUPERINTENDED BY THE ENGLISH ARCHITECT.

The evidence that a bargain had been struck between the English merchant and Chinese contractor, appeared on my plans in the form of a perpendicular column of characters neatly traced with a brush and Indian ink. My employer would not have the specification translated. "You'll have no difficulty with Achone," he said, "he's been a ship carpenter, and is well accustomed to building for the Europeans, and he'll do anything you ask him. They're infernal rogues, these Chinamen, confounded rogues, *all* of 'em, but they know I'm too deep for 'em, they can't cheat *me*." The foundations being laid about four feet thick, of long masses of granite as large as a milestone, I felt there was less necessity to oblige the contractor to dig up some large natural rocks that interrupted the level of the trenches. We had a serious difference of opinion, however, about these rocks; Achone declared that if they were extracted, the soft bed underneath them would swamp the footings. I was pleased to observe a proper English mason's level employed in place of the clumsy water trough generally used by the Chinese. The three customary courses of granite ashlar, above the plinth, to keep out *laleeloons* (thieves), were a long time in laying. I admired the patience of the masons, each perched upon a block, punching with iron hammer and chisel steadily through the long, long summer hours, snatching only a few moments for the simple refreshment of little else but rice and tea, and a few whiffs at a pipe, without stepping off their block.

When the granite window-sills were laid, each having a central perpendicular stroke struck with a line wetted with muk suey (Indian ink,) and brought accurately to coincide with the centre of the window marked on the masonry below, and the jambs were set up, the bricklaying began. The face of the wall was kept exactly flush with the granite below, leaving not a quarter of an inch for plastering. The grey-headed—I mean grey-tailed, veterans of the trowel had never thought of this, and vociferated most fiercely when made to pull their work down by the foreman.

I was dumb-founded to see the plasterers treading on the heels of the bricklayers, and laying on the pricking-up coat as fast as the wall rose in height; being very thin, this plaster is not disturbed by the settling of the brickwork. Screeds were altogether rejected as wasteful; indeed the forming them would have been impossible, for to save scaffolding one part of the wall was always carried up nearly ten feet higher than others.

Achone was very troublesome about his instalments, which were paid at the merchant's treasury, on his presenting my certificates. He was to have one thousand dollars to begin with, a thousand when the foundations were in, and another when the first floor joists were laid. He had taken his contract so low, or ready money commanded such discount, that he quite led me a life.

One day, whilst the round spars were laying as bridging-joists upon some old masts as girders, that had already "put a girdle round the earth" in the merchant service, Achone put the question: "Can let my have thousant dallar now?" "No, you must do some more work first." "My wantshee catchee thousant dallar first. Have got twenty-five piece carp'nter man, forty piece coo-lee (labourer), thirty breek may-sun: suppose no got moa-ney, no can give wage dat man: you see—all dat stun foundation very large stun; eb'ry day I go out, dat coo-lee come talkee my—why no give moa-ny?—ebery day wantshee moa-ny, buy dat rice;" and in his agitation he inserted a great fan under his white jacket, and began to ventilate his spine most vigorously. "Inside my heart werry sore, no can catch wage; all dat coo-lee man come roun my ous, make *to--o* much barbry,—say,—Achone! Achone! You all same tief Achone! Talkee too much bad my." "Well, why don't you send to Canton and get more joists?" "My *hab* sendee Cantun. *No* can buy spar, no got *moa-ny*. You gib me thousant dallar, my catchee dat Cheena spar werry soon." And here Achone, overcome with sadness, lifted up his voice and wept. There is something remarkably touching in the sight of a strong, stout man shedding tears. "I never", as Corporal Trim says, "in the longest march, had so great a mind to my dinner, as I had to cry with him for company."

As soon as he was gone, I proceeded to the house of my employer to plead for him. "Is Mr. S. in," said I to a loitering, effeminate Chinese lad, with a smooth shaven head, after having doubtfully walked to and fro in the veranda, and knocked with very little effect at four or five sash-doors; "He av go out, wat choo want-shee, you makee house pigeon?" I acknowledged the compliment to the profession with a nod to the youth, and went to meet Mr. S.

"Oh, Mr. ——", said my employer, "when *you* know the Chinamen so well as *I* do, you won't be so tender-hearted as you are now: why that scoundrel Achone, living as he does rent free in a mat shed on my premises, dirtier, and more meanly than his men, he's one of the richest Chinamen in the place! No, no, let all the joists be laid first; he's got his thousands of dollars out at fine interest, *I'll* take an oath."

To return to the building: I had shewn my greenness in placing the strong room for the dollars against an outer wall, accessible to housebreakers; this was altered. We were now working at the level of the first floor, where the sitting rooms were to have fireplaces. To avoid corbelling, the joiners nailed a single floor board close to the wall, and based the brick jamb upon it. Every means was employed to save bricks, the windows gaped inwards with splays, that placed the lintels in a critical position. The granite door-jambs had awkward projections left for pivots to work in, instead of proper hook and twist hinges. When the marble hearths came, quite an excavation had to be made in the round spars, which could not be trimmed, and ran their inflammable ends into the fireplace, and the hearth could not be got down flush with the floor. It was useless to remonstrate; Achone knew that Mr. S. was satisfied with the regular way of doing things.

Part of the first floor was to be a veranda, with Doric columns and entablature; I had profiles cut for the rough brick work, which Achone vowed should be executed to a nicety, leaving three quarters of an inch for plastering everywhere. Unfortunately, I was compelled to leave the men to their own devices for a few days, and Achone to his opium pipe. When I came back—good heavens! what was the veranda like? The pillars were right in height, but the coupled columns were

stuck together; the bases, two clumsy toruses, in form something between a turnip-radish and a pumpkin; the capital was a single meagre tile. After having the columns reconstructed, the stucco work began. All the fillets and squares leaned inwards, the soffit of the architrave cut an inch deep into the abaci, the triglyphs were pentaglyphs, the cornice the masons would not project more than the half of a twenty-inch tile instead of nearly two feet (I got it done eventually with granite slabs). Instead of the plain blocking course designed, I found the industrious plasterers flourishing away in flowery enrichment, of a series of little piers, projecting from other slight projections, so that each division of the attic had six arrises, and the corresponding mitres in the moulding coping, to say nothing of intervening panels, all filled with elaborate designs. It seemed a sad pity to have to abolish all this exuberance, especially as the contractor never dreamed of an extra for it.

For the roof we had provided king post trusses; and when these were set up, the carpenters began to bed the hip pieces; four clumsy round pine logs—they were tied to nothing, had no square bearing anywhere—being just bedded in the brick walls, and the purlin spars rested on them. Upon these the tiles lay, bearing on battens rafterwise. The entablatures over the windows were great difficulties; in these the Chinese generally keep the return of the upper fillet within the width of the window dressings (see figs. 9 and 14); and when I ordered the extra length, they ran all the members out alike. I corrected this by tracing the return of the bed-mould against the wall. Then they cut crown mould and all off to this mark, and had to insert bricks again to repair their mistake. Every morning some blunder stared me in the face. One day I found all the window outside architraves painted green to match the jalousies.

A large shed, shaggy with its thatch of dry leaves, close to the building, accommodated the joiners. Here they got up the sash doors, which are commonly used to both doorways and windows to assist the ventilation: preparing the stiles on little forms, not more than six feet long, the bench sloping from about twenty-four inches to twelve in height. With a narrow plane, destitute of top iron, and worked with a cross handle, the workman sitting astride his work, it was wonderful to witness what true and smooth work they put out of hand. It appeared rather barbarous, indeed, for a man to be turning up his naked toe and holding a sash-bar with it on the bench, while he worked the moulding and rebate. They were not so *au fait* at fixing. To my dismay, I found the doors, two inch double-worked doors, hung with brass butts, before the floors were laid; there was no fear, to be sure, of the doors not shutting, as there was above half an inch clear of any possible floor board, and when the floors were down, there was little more cause for satisfaction; huge ragged-headed brads attached them to the round spars, that could not be termed joists, and where an inequality presented itself, a dull adze scrubbed off the raised edge.

Mitering the moulded architraves was always a difficulty; the bead had to be shaved down, and the faces curved at the intersections.

The carving was worse than the joiner's work. A console truss to a door cornice they incised in flat lines on a half inch board, though shown the front and profile on paper; and when a deal block was got out, the carver played with it as a cat with a mouse, and I was obliged to hack it out myself by inches to show him the way. A model would have helped on matters much, for but few workmen could understand a drawing.

Long before the building was finished, all the joints of the panels of the doors and sash door windows gaped wide, and let in streaks of the withering rays of the sun most provokingly. The cedar treads and risers of the stairs also shewed seams most unseemly. We made a cylinder in the well hole and chalked up the handrail pretty correctly. The greatest proof, perhaps, of want of civilization shewed itself in forming the access to the cellar in the staircase compartment, about fifteen feet square. Instead of contriving the descent under the staircase, they boarded the whole floor before beginning to *build* the staircase, and sawed out a large square trap in the centre of the apartment to get at the cellar. For the balustrade to the verandah, which was to be of grey porcelain, they brought several stone bottle-like productions, glazed, which could be produced at about half a dollar each. I gave them a profile, which they executed with very round arrises.

As soon as the rooms were floored, the workmen, who had been roosting at night like fowls on little perch-like platforms in the roofs of the temporary workshops, brought their beds (little more than mats) into the house, and there some of them lay sprawling and fanning themselves through the day. This appeared much more innocent than an English mechanic's week's "fuddle"; nevertheless I said to Achone, "Why do you let your men leave their work and smoke?" "Cheenaman", he replied, "no all same Inglis-man. Spose Inglis carp'nter ten minest away from walk, stoppee he wage—Cheenaman no all same. Dat man (pointing to one) stun may-sun, to day he no got walk, to-morrow he catchee walk, nex day spose no got —spose rain come, he catchee lice (rice);" that is, in rainy weather, when they cannot work, there is an allowance of rice to the mechanics, who get about the third of a dollar wages per day, or sixteen pence; labourers about sevenpence half-penny.

Centre flowers of radiating acanthus leaves, were most patiently modelled against the ceilings of the best rooms, and in tolerable imitation of my drawings, but in a few days they cracked and fell to pieces, whilst the quaint sprigs, birds, and fishes, shaped by the plasterers out of their own heads, set beautifully hard; seeming to say, this is a land of old institutions, new fangled notions will not answer here.

At an early stage in the works one of the ground floor rooms was furnished thus; against the wall were some upright boards, about seven feet high, the upper part covered with orange paper, inscribed with black characters, and in some parts punched into rows of diamond-shaped apertures, and spangled with square spots of gold leaf, its surface further diversified with little bouquets of tinsel, fructifying most gloriously with red and green gems. A small table stood close to the boards, on it were two earthenware lampstands, a little blue and white teapot, some diminutive basins, a vessel containing a large green fruit, and some matches, or incense sticks, in stands.

This altar was in honour of Lu Parn, or Lao Parn, the "opifer per orbem dicor" of Chinese carpenters. His interesting biography was thus touched upon by Achone: "He lib long time go, he werry cleb man,—savey all dat carp'nter pigeon (business), all dat stun walk, all same Inglis man (I bowed) savey make—all carp'nter man, all breck may-sun, all stun may-sun, chin chin he (worship him). Ten tousand year,—more, he makee die, go upside sky—make dat emp'rers house. Emp'rer makee he mandaree, he werry prarper man, all same school master; when got werry hard walk all man chin chin he (invoke him), all same Inglis man talkee chin chin Jos" (idol worship). "Well, but," said I, unwilling to appear to assent to his mythology, "Englishmen will tell you that 'Jos pigeon' is only fools' pigeon. There is only one God, and Chinamen have no more. He does everything well, and will not allow what is bad." "Oh, yes, my savey dat Gott berry well, he all same Jos." "No, he is not all same Jos." "Yes, my savey dat Gott, my likey Cheenamen Jos more better; Cheenaman Jos let him makee walk, catch wage S'nday. Inglisman Gott say no walk S'nday." Achone was too courteous to stick to any opinion he advanced when opposed by me, so it became in matters civil as well as religious, useless to "argue the point" with him.

We have yet to describe the plumbing, painting, and glazing, to complete our mansion. Of the first we may safely say there was none, the hard lime furnishing the linings of all the gutters, and the water closets being on the night-table principle.

Paint is laid on sometimes in almost a paste, with a piece of chip, and is very glossy when dry. Glazing is done as with us. The Tong yao fooi, lime and oil (putty) is as indispensable to Chinese joiners as to the English, and the glaziers, accustomed to work their oyster shell into labyrinthine compartments of carved casements, find sash squares very easy to stop in.

We have thus imperfectly traced the progress of construction, and the difficulties which occur in the erection of an ordinary English house, where all is square work, line and rule work. A little reflection on the clumsiness and inaccuracy displayed by Chinese artisans in such simple constructions, awakens our wonder at the truth and correctness with which the complicated curves of elaborate temple roofs are produced, bristling with porcelain dragons, fishes, frets, and scrolls, exhibiting contortions of eaves, board, gable, ridge, and hip, setting geometry at defiance, and yet in a manner symmetrically subservient to some of her rules, seeming, in the quaint contour of their fantastic crestings, to be less the productions of a plodding, persevering, unchanging people, than the magic creations of a race of fairies.

EDWARD ASHWORTH.

DESCRIPTION OF THE PLATES.

PLATE 1 shews the exterior of the only good Chinese mansion existing at Victoria, Hong Kong, in 1845, when the picturesque screen was pulled down to give place to three shop frontages. There is a small garden within the screen. In the lower subject, the naked purlins seen through the open jalousies determine the style of interior finishing of a private house.

PLATE 2. An interior view in the house represented in plate 1. The joiner's work is all of pine, coated with green paint and varnished. A spangling of gold enriches the sash doors. The walls (externally to the verandas) are naked brick, the ceilings boarded.

PLATE 3. Fig. 1, a Temple, not, as is usually the case, open all day. The transom beams and sculptures to the pillars are all in granite, the ties between the pillars and wall behind of wood. The palings to this and Fig. 2 are simply boards, about one and a quarter inch thick, painted red. Fig. 2, part of a tea merchant's dwelling at Canton; and Fig. 3, the front of a Temple at Macao.

PLATE 4 shews shops of a grade superior to those in Plate 5. These, however, are all open by day to the winter's cold. The poles and boards seen above the roofs are to shelter the street, only perhaps eight feet wide, from the sun.

PLATE 5. A street in Macao, the Chinese part of the town. These shops are quite second rate. The foolish custom of constructing segment roofs to verandahs is here displayed to disadvantage.

PLATE 6. Fig. 1 is the roof of a large warehouse on the "Surrey side" at Canton. It is genuine Chinese. Fig. 2 may have been infected with the English *Queen's* dominion at Victoria, Hong Kong. Fig. 3 shows the mode of transporting heavy weights. Fig. 4, from a warehouse at Canton, is a specimen of native carpentry. It wants the purlins to be complete. Fig. 5, are the puncheons to a larger scale; and Fig. 6, another example of Chinese construction.

The following publications upon the history and manners of the country include those referred to in the text. The earlier works will be found to be foundations of those of later date, as few of the modern writers, excepting those who accompanied the embassies, have had the privilege of ascending the country to make their own observations.

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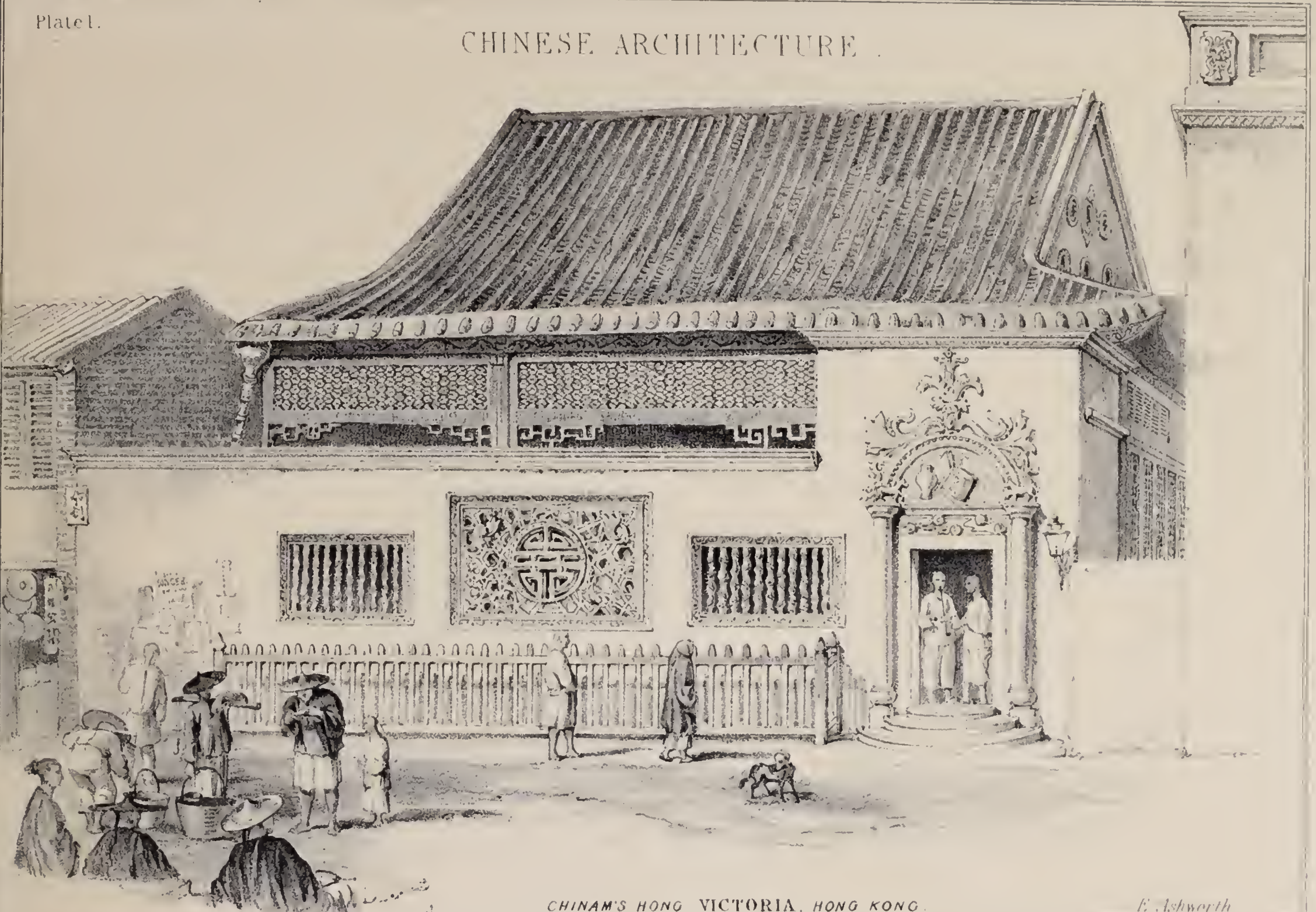
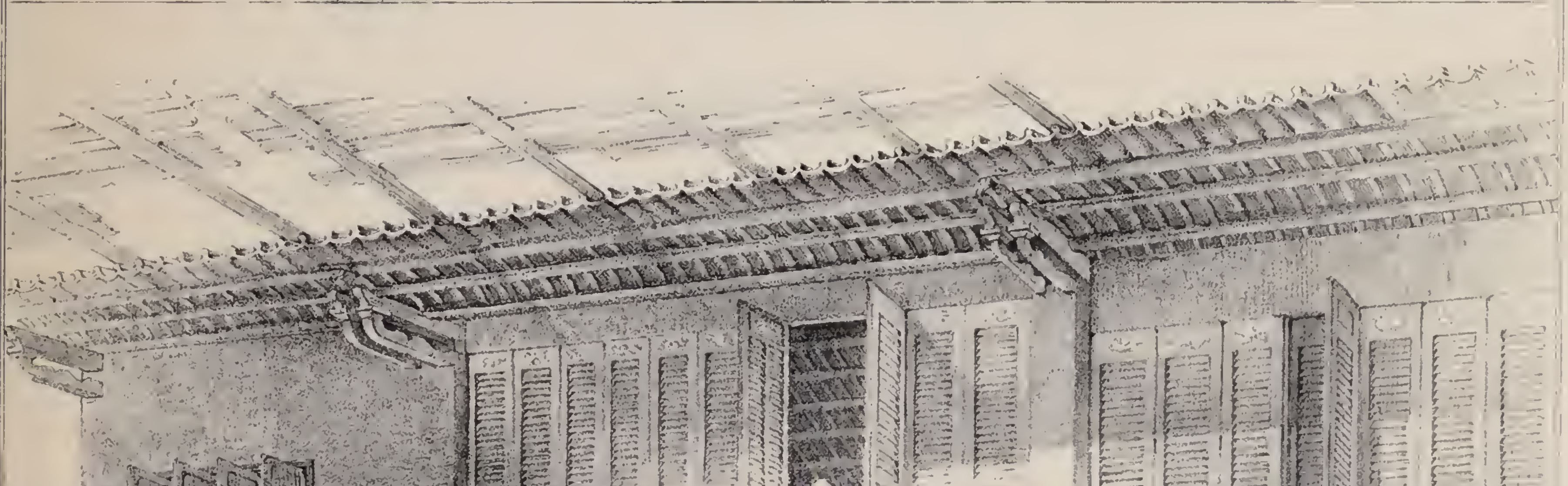
Plate I.

CHINESE ARCHITECTURE.



CHINAM'S HONG VICTORIA, HONG KONG. E. Ashworth



PRIVATE DWELLING HOUSE CANTON E. Ashworth

Lithographed by Day & Son, Sep. 30th 1851

Plate 2.

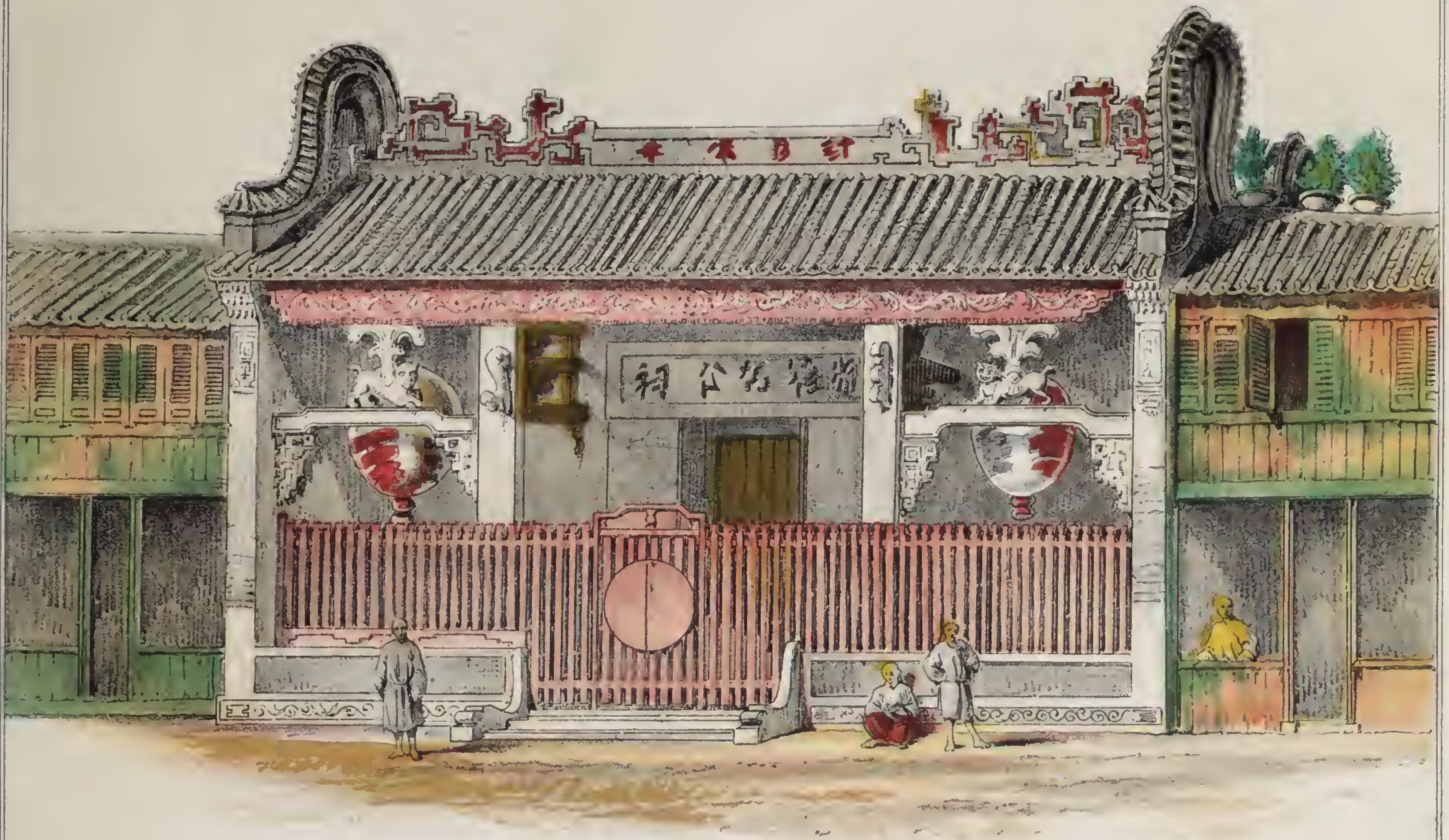
CHINESE ARCHITECTURE.

INTERIOR OF CHINAMAN'S HONG_VICTORIA_HONG KONG.

E. Ashworth

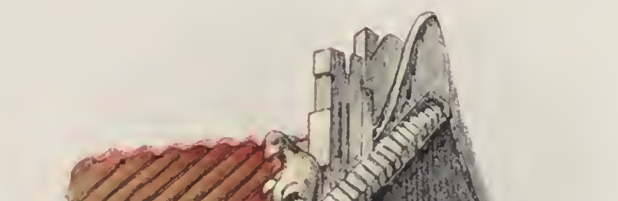
Plate 3

CHINESE ARCHITECTURE.



MIU TONG. CANTON

PART OF A TEA MERCHANT'S DWELLING HOUSE
CANTON.



GABLE END OF TEMPLE
MACAO.

F. Ashworth

Lithographed by Messrs Day & Son Sept 30th 1851

Plate 4

CHINESE ARCHITECTURE.

STREET SCENE. CANTON, near the Foreign Factories.

E. Ashworth

Lithographed by Messrs Day & Son, Decr 30th 183

Plate 5

CHINESE ARCHITECTURE.

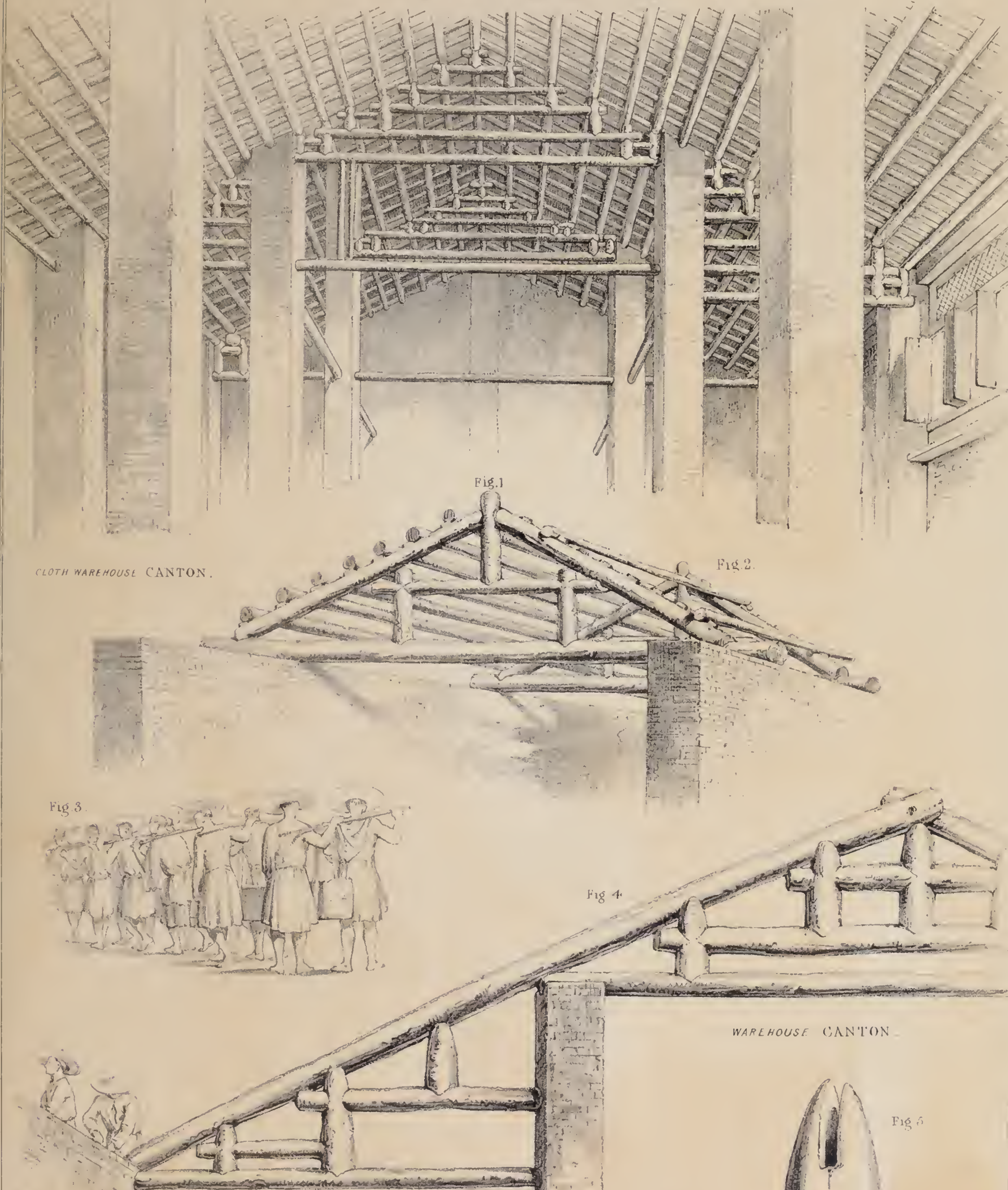
F. Ashworth

CHINESE STREET, MACAO.

Lithographed by Mess. Day & Son. Sep. 30th 1851

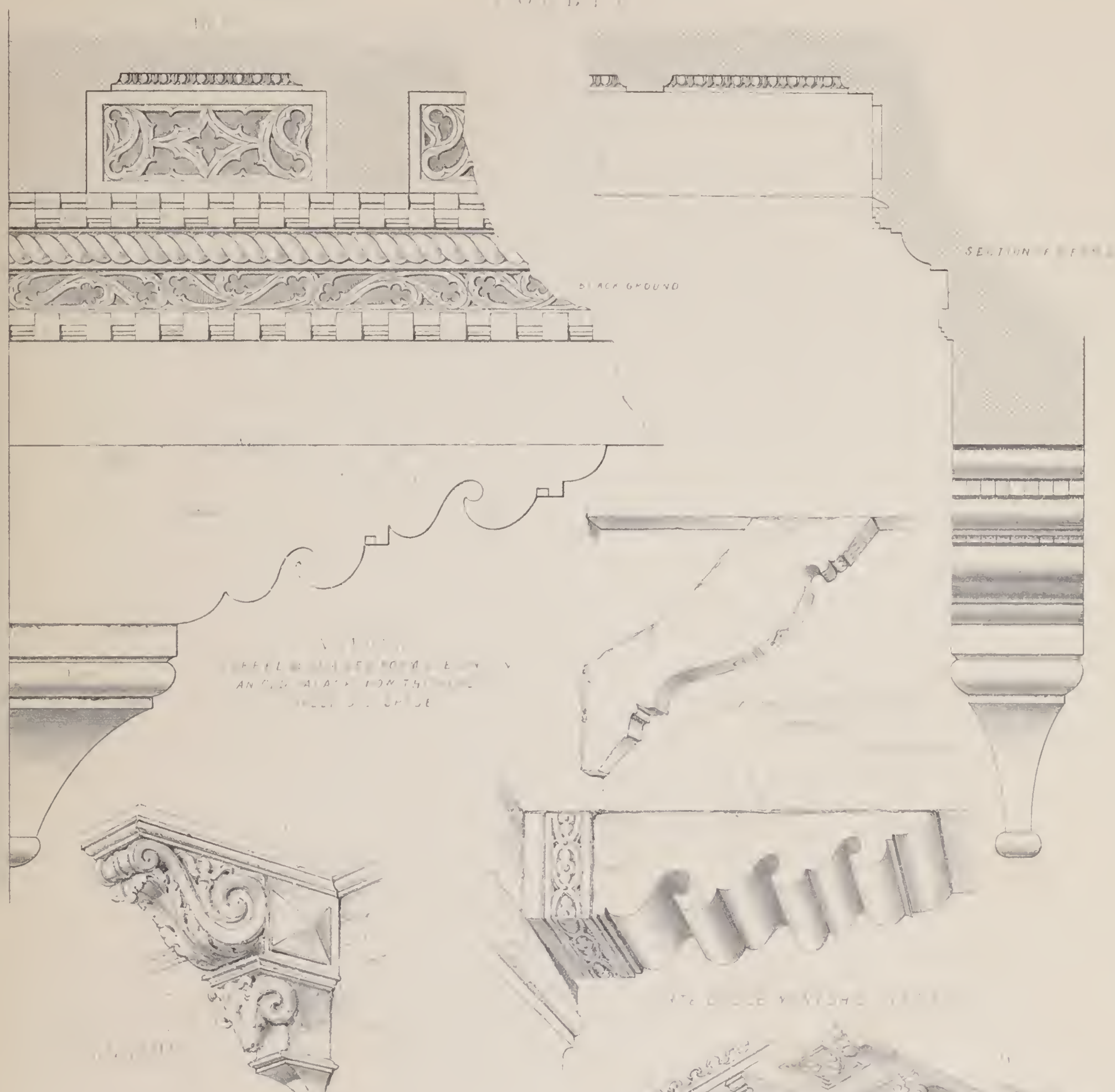
Plate 6.

CHINESE ARCHITECTURE



Lithographed by Mess.rs Day & Son Sep.t 30th 1851

CORBEL



CORBEL.

Fig. 1

FLORENCE
BEHIND OR SAN MICHELE

Fig. 2

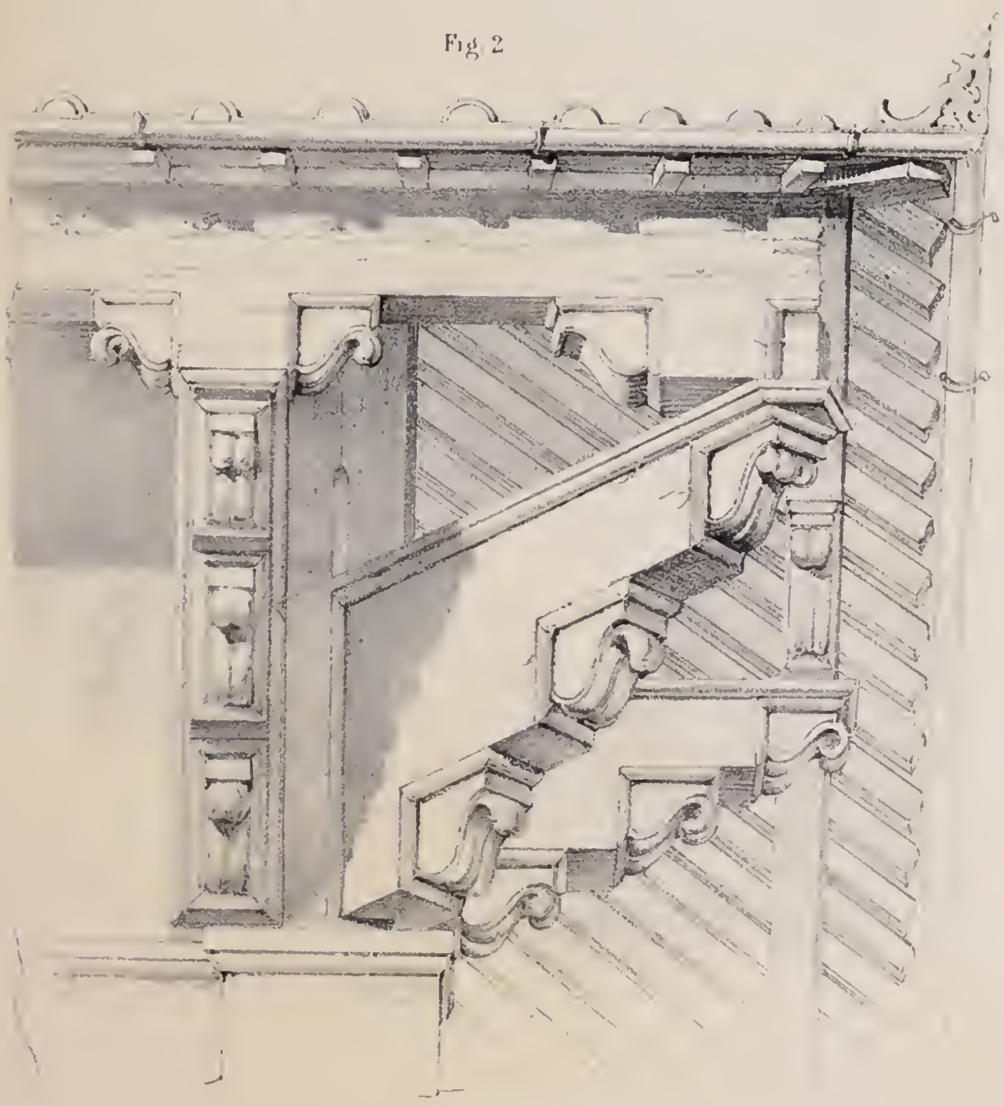
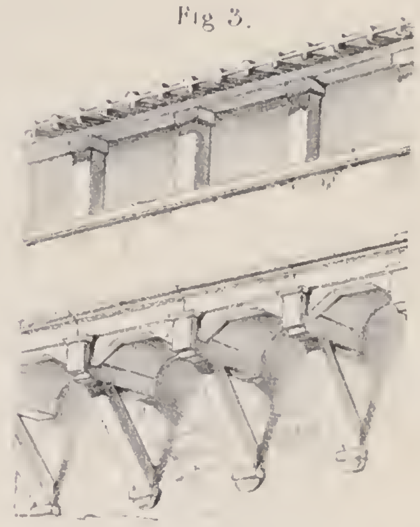
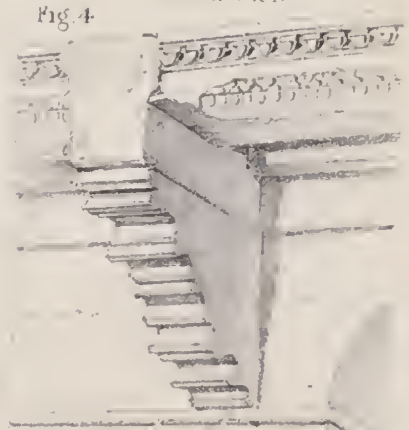


Fig. 3.



LEGHORN

Fig. 4



FLORENCE
Piazza del Duomo

PISA
Via S. Martino

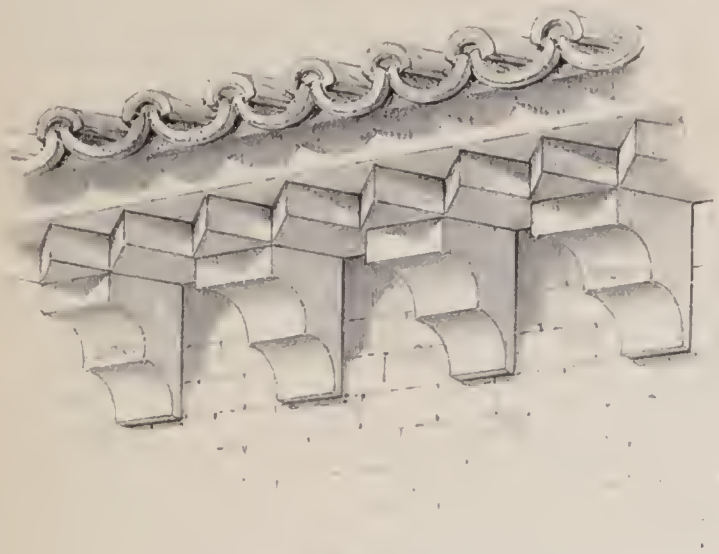
Fig. 1 2 4. T H Lewis, M I B A

Fig. 3 Sydney Smirke M I B A

Lithographed by Mess.rs Day & Son, ... 25th 1850

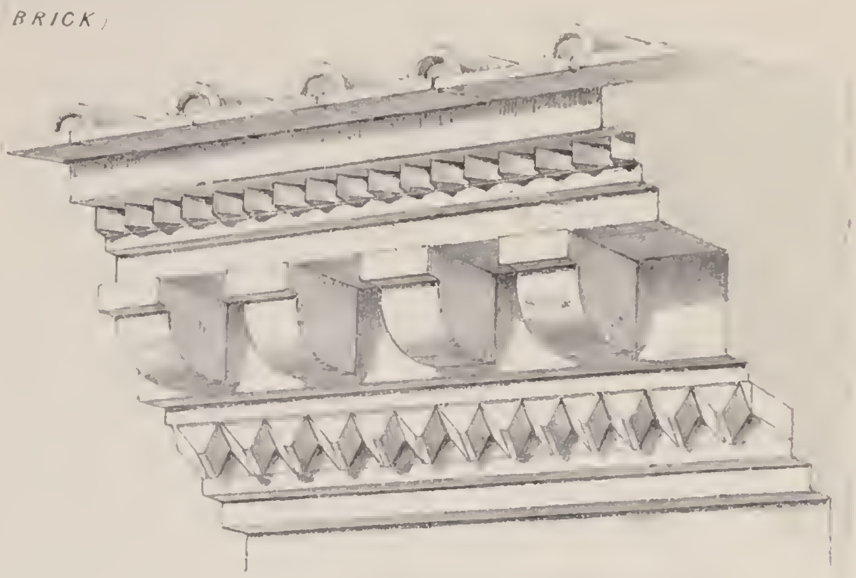
Lithographed by Messrs Day & Son, March 24th 1851

CORNICE.
(BRICK.)



CAMPO SANTO. ROME.

M. Digby Wyatt

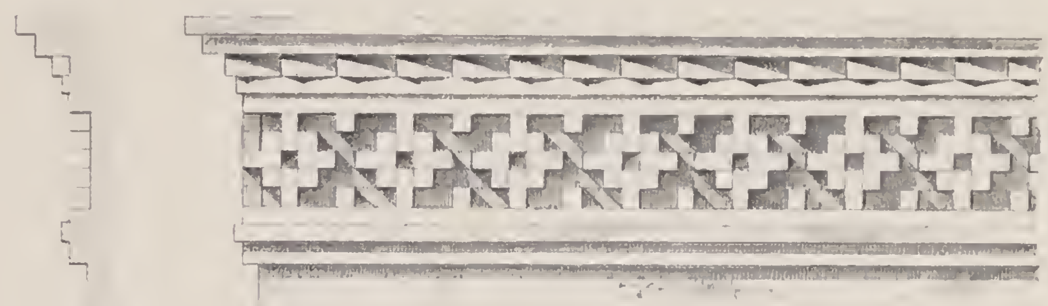


CHURCH of SAN GIORGIO in VELABRO. ROME.

M. Digby Wyatt

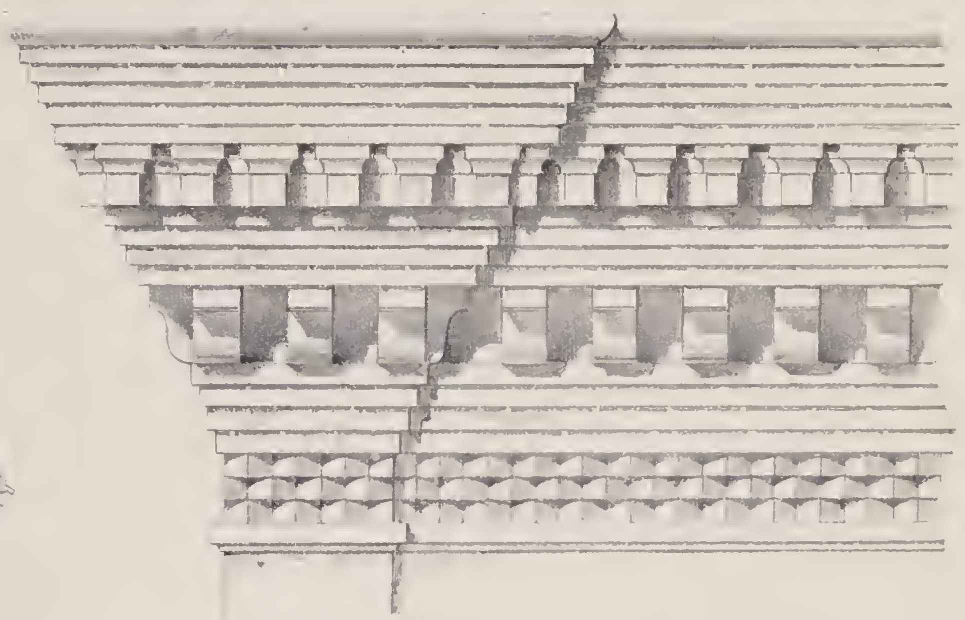
CHURCH of SAN STEPHANO. FERRARA.

Digby Wyatt



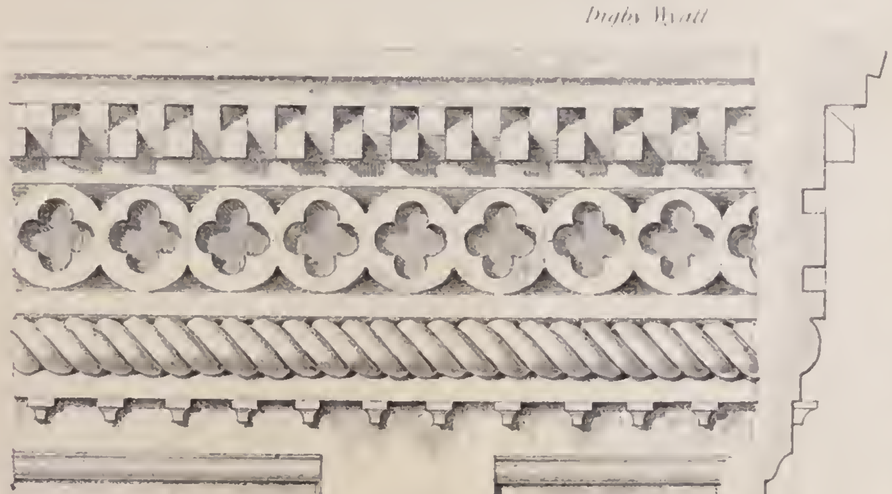
CHURCH of the SERVI. — BOLOGNA.
1392.

James M. Lockyer, M.I.B.A.



THE GREAT HOSPITAL. — MILAN.

H. B. Garling Jun. M.I.B.A.



SANTO STEFANO. VENICE.
1325.

James M. Lockyer, M.I.B.A.

AT BOLOGNA.

Cha^s Fowler Jun^r

CORTILE

PALAZZO CAPRAROLA

Herr Diebusch.

DEY'S PALACE,
ALGIERS.

Printed by Hullmandel & Walton 1st Novr 185

COURT.

Herr Diebitsch P.C.A. lith.

HOUSE OF THE PROVINCIAL ASSEMBLY.
BARCELONA.

Printed by Hullmandel & Walton, 1st Novr 1852.

COURT.

A. J. Green M.I.B.A. P.C.A. lith.

QUADRANGLE OF HOUSE IN THE VIA AMALFITANIA
SYRACUSE.

Printed by Hullmandel & Walton, 1st Novr 1852

THE ELEMENTS OF DESIGN,

EXTRACTED FROM

THE SECOND CHAPTER OF THE FIRST BOOK OF THE WORK

DE ARCHITECTURA,

BY

MARCUS VITRUVIUS POLLIO.

LIBER I. CAPUT II.

EX QUIBUS REBUS ARCHITECTURA CONSTET.

Architectura autem constat ex ordinatione quæ græce τάξις dicitur et ex dispositione: Hanc autem græci διάθεσιν vocitant et eurithmia et symmetria et decore et distributione quæ græce οἰκονομία dicitur: Ordinatio est modica membrorum operis commoditas separatim universæque proportiones ad symmetriam comparatio hæc componitur ex quantitate quæ græce ποσότης dicitur: Quantitas autem est modulorum ex ipsius operis sumptio e singulisque membrorum partibus universi operis conveniens effectus: Dispositio autem est rerum apta conlocatio eligansque compositionibus effectus operis cum qualitate: Species dispositionis quæ græce dicuntur ἰδέαι sunt hæ ichnographia ortographia scænographia ichnographia est circini regulæque modicæ continens usus æqua capiuntur formarum in soliis arearum descriptiones. Ortographia autem est erecta frontis immago modiceque picta rationibus operis futuri figura: Item scænographia est frontis et laterum abscedentium adumbratio ad circinique centrum omnium linearum responsus hæ nascuntur ex cogitatione et inventione: Cogitatio est cura studii plena et industriæ vigilantiæque effectus propositi cum voluptate: Inventio autem est quæstionum obscurarum explicatio ratioque novæ rei vigore mobili reperta. hæ sunt terminationes dispositionum Eurithmia est venusta species commodusque in conpositionibus membrorum aspectus hæc efficitur cum membra operis convenientia sunt altitudinis ad latitudinem latitudinis ad longitudinem et ad summam omnia respondeant suæ symmetriæ: Item symmetria est ex ipsius operis membris conveniens consensus ex partibusque separatis ad universæ figuræ speciem latæ partis responsus uti in hominis corpore e cubito. pede palmo. digito cæterisque particulis symmetros est eurithmiæ qualitas sic est in operum perfectionibus

DE ÆDIBUS SACRIS.

Et primum in ædibus sacris aut e columnarum crassitudinibus aut triglypho. aut etiam embatere ballistæ foramine quod græci περίτρητον vocitant. navibus interscalmio quæ διφηχιακή dicitur: Item cæterorum operum e membris invenitur symmetriarum ratiocinatio: decor autem est emendatus operis aspectus probatis rebus compositi cum auctoritate. is perficitur statione quod græce θεματισμός dicitur seu consuetudine aut natura: Statione cum jovi fulguri et cælo et soli et lunæ ædificia sub divo hypæthraque constituentur horum enim deorum et species et effectus in aperto mundo atque lucenti præsentes vidimus minervæ et marti et herculi ædes doricæ fient. his enim diis propter virtutem sine deliciis ædificia constitui decet: Veneri flore proserpinæ fonticum phiscorinthio genere constitutæ. aptas videbuntur habere proprietates quod his diis propter teneritatem graciliora et florida foliisque et volutis ornata opera facta augere videbuntur justum decorem junoni. diane libero patri cæterisque diis qui eadem sunt similitudine si ædes ionicæ construentur habita erit ratio mediocritatis quod

BOOK I. CHAPTER II.

On those things of which Architecture consists.

Architecture consists of Ordination, which in Greek is called τάξις; Disposition, which the Greeks name διάθεσιν; Eurithmy; Symmetry; Fitness; and Distribution, which in Greek is is termed οἰκονομία.

Ordination is the adjustment as to size of the members of the work in themselves, in reference to their uses, and as compared with the scale of the entire design. This arises out of dimension, which in Greek is called ποσότης. Dimension, however, depends upon the agreement of each part of the members of the whole work, with a module assumed from the work itself.

Disposition is the just collocation of the parts, and the desirable effect in the composition of the work, with regard to quality. The drawings for the disposition, called by the Greeks ἰδέαι, are these: plan (ichnography), elevation (orthography), and perspective view (scenography). The Plan is the accurate delineation by compass and rule, from which is taken the form of the areas on the surface of the ground. The Elevation is the vertical representation of the front, and the figure of the future work, accurately drawn in proportion. The Perspective View is the shaded representation of the front and receding sides, and accordance of all the lines to the vanishing point. These are founded upon thought and scrutiny: Thought being the consideration, *con amore*, of the proposed subject, carried out with care, industry, and vigilance: Scrutiny being necessary for the solution of obscure questions, and to give the reason, for any novelty, discovered by quickness of apprehension. Such are the operations comprehended in the term Disposition.

Eurithmy is the graceful form and suitable appearance in the composition of the parts. This is realised, when the members of the work are in proportion—of height to width, of breadth to length—and where all agree to the perfection of their own proportion.

Symmetry, also, is the proper harmony of the members of the work itself, and the agreement of any given one of the several parts with the appearance of the whole; as in the body of man, there results, from the elbow, the foot, the palm, the finger, and the other parts, a symmetry (which constitutes a quality of eurithmy); so also there is (a like relation) in the perfections of buildings. And, as in sacred buildings, from the diameter of the columns, or from the triglyph, a scale is found; as in the balistæ, by the size of the hole which the Greeks call περίτρητον; and in ships, from the space between the thowls, which is termed διπηχαική; so in other works from the members will be found a settled scale of symmetries.

Fitness is a correct aspect of a work composed of parts, approved with the sanction of precedent or authority. It consists of propriety (in connexion with the destination of the building), in Greek termed θεματισμός; of (accordance with) custom; and of (attention to the) nature (of the site). The first

et ab severo more doricorum et ab teneritate corinthiorum temperabitur eorum institutio proprietatis: Ad consuetudinem autem decor sic exprimitur cum ædificiis interioribus magnificis. Item vestibula convenientia et elegantia erunt facta. si enim interiora perfectus habuerint elegantes aditus autem humiles et inhonestos non erunt cum decore: Item si doricis epistyliis in coronis denticuli sculpentur. aut in pulvinatis columnis. et ionicis epistyliis capitulis exprimentur. triclyphis translatis ex alia ratione proprietatibus in aliud genus operis offendetur aspectus aliis ante ordinis consuetudinibus institutis: Naturalis autem decor sic erit. si primum omnibus templis saluberrimæ regiones aquarumque fontes in his locis idonei eligentur. in quibus fana constituantur. Deinde maxime æsculapio saluti et eorum deorum quorum plurimi medicinis ægri curari videntur: Cum enim ex pentilenti in salubrem locum corpora ægra translata fuerint et e fontibus salubribus aquarum usus subministrabuntur celerius convalescent. ita efficietur uti ex natura loci majores auctasque cum dignitate divinitas excipiat opiniones

DE OSTEIS OPERUM ET BALNEARUM ET FENESTRIS.

Item naturæ decor erit. si cubiculis et bibliothecis ab oriente lumina capiuntur: balneis et hibernaculis ab occidente hiberno pinacothicis et quibus certis luminibus opus est partibus a septentrione. quod ea cæli regio. neque exclaratur. neque obscuratur solis cursu: sed est certa immutabilis die perpetuo.

DE QUALITATIBUS LOCORUM ET COPIIS OPERUM.

Distributio autem est copiarum locique commoda dispensatio parcaque in operibus sumptus ratione temperatio. hæc ita observabitur si primum architectus ea non quæret quæ non potuerunt inveniri aut parari nisi magno Namque non omnibus locis harenæ fossiciæ nec cæmentorum. nec abietis. nec sappinorum. nec marmoris copia est. sed aliud alio loco nascitur quorum conportationes difficiles sunt et sumptuosæ. Utendum autem est ubi non est harena fossicia fluviatica aut marina lota:

Inopiæ quoque abietis aut sappinorum vitabuntur utendo cupresso populo ulmo pinu reliquaque his similiter erunt explicanda:

Alter gradus erit distributionis cum ad usum patrum familiarum et ad pecuniæ copiam aut ad eloquentiæ dignitatem ædificia alte disponentur:

Namque aliter urbanas domos oportere constitui videtur aliter quibus ex possessionibus rusticis influunt fructus: Non idem feneratoribus aliter beatis et delicatis potentibus vero quorum cogitationibus res publica gubernatur. ad usum conlocabuntur et omnino faciendiæ sunt aptæ omnibus personis ædificiorum distributiones.

This text is taken from the codex ascribed to the ninth century, and numbered 2767 of the Harleian Collection in the British Museum. It has been collated with the other codices in the same library, of which the following are the respective numbers: Harleian, 2508 (A), 2760 (B), 3859 (C), 4870 (D); Cottonian, Cleopatra, D. 1. (E); Arundelian, 122 (F).

The letters affixed to each, distinguish the authority from whence the notes are derived, being the several readings of the various manuscripts; the material differences only having been noticed.

The codices are all written without regard to punctuation; but the selected one has been strictly adhered to in that matter. It will be observed, that generally a pause is distinguished by only one point, while two mark the close of a period.

The subdivisions of this chapter are probably injudicious interpolations of the mediæval transcribers.

Line 2, *ex* omitted, A; l. 3, *vocant diatesin*, A; l. 6, *positionis* for *proportiones*, D; l. 7, *hæ componunter*, A; l. 9, *sumptione*, F; l. 14, *equa*, A F; *continentur formarum*, A; l. 14, *e qua......in solis*, D; l. 21, *explanatio*, A; l. 21, *ratione*, C D E; ll. 34 and 35, *interscalpio*, B C D E; l. 38, *probatus rebus compositis*, B D; l. 41, *constituerentur*, A; l. 42, *videmus*, A D F; l. 45, *Fontium nymphiis*, D, *Fonti cum phis*, E, *Fonti cumphys*, altered in margin into *Fonticum nymphis*, C, and into *Fontium nymphis*, F, from *Floræ* to *justum decorem* omitted, A, *Fonticum phiscocorinthio*, B; l. 48, *augeri*, E; l. 49, *constituentur*, B; l. 53, *cum ædificiis magnis*, C E; l. 55, *perspectus*, F; l. 57, altered in margin into *pulvinatis capitulis et ionicis epistyliis exprimentur triglyphi*, F; l. 62, *eligantur*, D; l. 74, *certa et immutabilis*, C D E F; l. 76, *autem operum est*, C E; l. 78, *eam non......potuerit*, D; l. 79, *nisi cum magno*, B D; l. 79, *non in omnibus*, C; ll. 80 and 84, *sapinorum*, D B; l. 83, *aut maxime lota*, A; l. 88, *aut ad pecuniæ*, F; l. 90, *aliter est quibus*, A; l. 92, *alter*, C.

directs, that temples to Jupiter Thunderer, and to Cœlus, and to the Sun, and to the Moon, be erected without roofs, and hypæthral; for we see around us the effect and appearance of these deities in the open air and broad light. To Minerva, Mars, and Hercules, Doric temples should be built; for to these gods, because of their masculine valour, it is proper that buildings should be erected without ornament: edifices in the Corinthian order to Venus, Flora, Proserpine, and nymphs of fountains, will seem to be appropriate, because more graceful and florid works, ornamented with volutes and adorned with leaves, will seem to be better adapted to the feminine character of these deities. If to Juno, Diana, Bacchus, and other gods who are like unto them, Ionic temples should be built, then will be attained a due mean, because the style suitable for them is a modification between the severity of the Doric, and the delicacy of the Corinthian.

In respect of custom, too, fitness is in like manner maintained, when buildings with magnificent interiors have suitable and elegant vestibules. For if the interiors should be elegant, but the entrances of poor and mean appearance, there would not be fitness. So, if in the Doric entablatures, dentils be carved, or if triglyphs be introduced in the entablatures on pulvinated capitals and Ionic columns, proprieties of one style being transferred into another, the sight will be offended, from the use of peculiarities contrary to established custom. But natural fitness will thus arise; for if healthy sites and fountains of water are thought necessary in those places, in which shrines are to be raised to any of the gods, then especially would they be so in the case of Æsculapius, of Salus, and of those divinities by whose medicine many sick men are seen to be cured. For when invalids are transferred from a pestilent to a healthy place, where the supply of water is furnished from pure springs, they will the sooner convalesce. Thus it will result from the nature of the place that the divinity will be more thought of, and held in greater reverence.

Also the fitness as to nature will be attended to, if for chambers and libraries light be obtained from the east; for baths and winter apartments, from the west; for picture-galleries and others, in which a steady light is required, from the north; because that region of the sky is neither made lighter nor darker in the sun's course, but is steady and unchangeable throughout the day.

Distribution is an advantageous use of the materials and site, and a frugal expenditure in the execution. This will be observed, if the Architect does not ask for those materials which cannot be found or procured except at great expense. For there is not in every place plenty of pit-sand, cement, fir, larch, or marble, but one or other may be procurable only in another locality; and the carriage, consequently, difficult and expensive. So that, where there is no pit-sand, river or sea-sand must be used, being first washed. The want of the fir or larch may be obviated by using cypress, poplar, elm, or pine: other difficulties, also, may have to be got over in like manner.

Another branch of distribution is, when the buildings have to be arranged according to the wants of the head of a family, or in proportion to the wealth, or to the dignity of eloquence of the owner. For it appears, that city houses should be arranged in one way; but a different distribution must obtain in the residences of those, who derive their means from the produce of their lands; one system for traders; and another for the rich and luxurious; but for the powerful, by whose thoughts the state is governed, the houses must be adapted to their position; and, in short, the arrangement of buildings must ever be suited to the wants of the persons requiring them.

It is not intended to present the above translation as a literal rendering of the text of the English codices in particular, but rather of what is presumed to be a faithful representation of the original text emended by reference to other authorities.

OBSERVATIONS.

Architecture may very properly be regarded in a three-fold view, under those distinct courses of study necessary to produce the perfect Architect, whom Vitruvius describes. It is a science; an art of design; and a practical or mechanical art. Under all these three aspects does our author contemplate it, in the opening of his work. He begins the first chapter by considering it as a science, embracing an extensive range of knowledge, both theoretical and practical. The former of these branches, admitting only of a general treatment, in a work of his scope, he disposes of in the same chapter, recurring to it occasionally, as opportunity offers; but the *practical* knowledge necessary for an Architect, so far as it can be gleaned from writing, he discusses at considerable length, in the latter chapters of the first, and the whole of the second, seventh, and eighth books.

In his second chapter, he proceeds to consider architecture as an art of design (or the *ratiocinatio artis*, as he elsewhere calls it), having reference to practical utility; and lays down very distinctly, and with equal truth and beauty, those principles or elements of composition, by which every architectural design should be tested, before it is put into execution.

In his third chapter, after specifying the three heads, under which architecture, as then practised, ranged itself, he adverts briefly to the points requiring attention in the *opus* or *mechanical* execution of the design.

It is under the aspect explained in the second chapter, that we wish more particularly to consider the subject, on the present occasion.

This chapter, more, perhaps, than any other part of the writings of Vitruvius, not even excepting the *scamilli impares*, the *de harmonia*, or the *vasa theatri*, has been an ænigma and a stumbling-block to all those who have undertaken, either to explain or translate the text of our author. Barbaro and Scamozzi, though at great pains to elucidate it, have left it involved in rather greater obscurity than originally invested it. Philander and Poleni, despairing of throwing any light upon it, have left it untouched; and Perrault hesitates not to say, that "no one can discover the essential difference of ordinance, disposition, and distribution in a building, nor how proportion can be considered as distinct from these, seeing they can none of them be effected without attention to this principle"; and in his translation, resigning all hope of arriving at the true sense of the text, he manifests a characteristic boldness, in altering it to suit his own conceptions of the should be, wisely judging *that* to be the readiest means of solving this gordian knot. Lastly, Newton, with somewhat more show of modesty, acknowledges that the words seem put together in such a manner, as to have neither "coherence nor sense".

The translators have been scarcely more happy. Barbaro and Orsini, Perrault and Martin, Newton and Gwilt, have all fallen into errors, more or less gross, either in the rendering of specific words, or in the general conception of their author's meaning.

It is indeed matter of no surprise that all this obscurity should exist. Vitruvius confessedly compiled his treatise, in most part, from Greek authors; and he endeavours to embody and explain their lessons of art in a tongue, into which their terms had never yet been translated. Moreover, he is, in this part of his work, treating *in the abstract* a subject of much abstruseness. He is the only author we possess, either Greek or Roman, who has treated upon that subject; and even *he* handles it in a very concise and summary manner, presupposing his Roman reader to be prepared by education to understand a technical classification familiar in the schools of his period. The difficulty is yet increased, by his using, perhaps unavoidably, a confused phraseology, in employing the same term to explain one of his six principles, which he makes to express another.

It is owing to the ambiguity arising from our ignorance of his technical terms in their true force and meaning, and the consequent doubt that hangs over many of his passages, that his writings have, of late years, lost, instead of gaining, in general estimation with the professors of the art of which they treat. In this age of railway rapidity, when royal roads to every attainment are expected on all hands, and books, of more or less pretension and merit, have been multiplied in every department of art, no wonder if the old-fashioned, dry, and uninteresting because unintelligible, pages of a Latin author, are in danger of being discarded for the supposedly more rational and practical works of a later date. The architectural student, anxious to come at once at the fundamental principles of his profession, sits down to consult the father and oracle of the art. Scarcely have his fears of final success been excited by a summary of the talents and acquirements necessary for an Architect, before he is arrested in his studies by a metaphysical disquisition not easily comprehended, and of which, should he venture to consult any of the general interpreters, he is not likely soon to arrive at the meaning. Discouraged and disgusted because disappointed, he impatiently closes the book; and instead of attributing his failure to his own want of apprehension or perseverance, he concludes that the author was either lunatic, or ignorant of that which he professed.

Such a mode of study will not suffice for an Architect. The necessary knowledge is not to be gained but by diligent and persevering application; nor is it, when obtained, to be reduced to practice, with anything like good effect, without unremitting attention and repeated assays.

That the Greeks had reduced their architecture to a highly elaborated system, and studied it upon scientific principles well digested, can, I think, scarcely admit of doubt, if we only remember that—They so greatly excelled in its practice;—They were a people loving philosophical investigations of every description;—We have still remaining elaborate and deeply argumentative treatises upon the arts of speaking, writing, and other sciences and non-plastic arts;—The subjects treated of are reduced to first principles;—They had public schools and places of general resort, where such questions were constantly agitated; and spent all their time (the Athenians at least) in hearing or telling some new thing; and, finally, they actually wrote elaborate works on architecture, the names of many of which have descended to us.

Rome derived her knowledge of art from Greece. The concurrent testimony of all history affirms that—

> Græcia capta ferum victorem cepit et artes
> Intulit agresti Latio.

Vitruvius professes to give us the six Greek divisions of architectural design, in the chapter under consideration; and the only reason for doubting its authenticity or correctness, is a certain obscurity with which his statement is supposed to be enveloped. If, then, it can be shown that he gives a just analysis of architectural design,—that the terms he uses are appropriate and consistent,—and that the order in which he places them is just and natural; a service will be rendered to the study of the art, and a powerful argument supplied in favour of the genuineness and authenticity of our author. The attempt is the more inviting, on account of the utility connected with it: for though any information respecting the *vasa theatri*, or the *scamilli impares*, may be more curious than useful, or, at the least, but seldom available for practical purposes, any light thrown upon the passage in question, would render it serviceable in every design we can possibly form, in whatever style conceived.

The principles of composition, which Vitruvius would have us ever keep in mind in the formation of an architectural design, are stated in the extract at the head of this essay, and are six:—

ordination, disposition, eurithmy, symmetry, decor (or fitness), and distribution.

Of these, the first is, perhaps, the most difficult, and certainly the most important, to comprehend and distinguish from the rest. And here let me premise, that it is not to be supposed that any one or more of the distinct principles here enumerated can exist totally independent of the others, any more than the elements of words can have their due, or indeed any, sound, without the assistance of each other.

Ordination, Vitruvius defines as "the adjustment as to size of the members of the work in themselves, in reference to their uses, and as compared with the scale of the entire design." Newton translates this passage thus: "Ordination is the proper modification of the members separately, and the regulation of the whole proportion and symmetry." But this is more nearly a definition of architecture generally, as an art of design. He has evidently been led into this error by taking the Latin word *ordinatio* in the same sense as we use the word Order. But that this is not its true sense, is evident from the fact, that Vitruvius makes here no reference whatever to the orders, but speaks *generally*; so that the whole of what he lays down in this chapter is equally applicable, whether an order be employed or not, which it could not be, if the very first step in the formation of a design must necessarily be the selection of an order. Besides, this definition, as Newton renders it, omits the three essential particulars noticed in the original, viz.,—the size of the parts, included in the word *modica*, their use, *commoditas*, and the general scale of the whole structure, *universæ proportionis symmetriæ*.

Galiani translates it, "un misurato commodo de' membri di una fabbrica presi separatamente, e'l rapporto di tutte le sue proporzioni alla simmetria"; a rendering very similar to the former, and almost equally defective. This is the more remarkable, because Galiani adds in a note, that ordination means the giving to the members of an edifice the size due to their use; an annotation, by-the-bye, which he has borrowed from Perrault, without acknowledging its author.

This latter, as already stated, proposes to alter the text, as the only means of making sense; an alternative not justified, so far as I can find, by any manuscript; and I think unnecessary, as perhaps any one will allow, who compares the above rendering with the original text.

The translation of Jean Martin is scarcely more correct: nor is that of Orsini; both of whom seem to have been at a loss for the real meaning of their author.

Barbaro translates it thus: "Ordine è moderata attitudine de i membri dell' opera, partitamente e rispetto a tutta la proportione al compartimento, il quale si compone di quantità"; a definition which defines nothing, but serves rather to conceal the meaning of the author than to explain it.

Sir Henry Wotton considered that *ordinatio* meant merely the adoption of a module for the whole work; a misconception to which we may probably trace Newton's error. He also imagined that *dispositio* was simply the plain expression of the forms or ideas of the design; so that he did not hold it necessary to include these two in his enumeration of the principles of architectural composition.

As, then, the translation above given requires no emendation or forcing of the text, is in itself plainly intelligible, and is borne out by Perrault, Gwilt, and Schneider, I hesitate not to adopt it. According to this, then, Ordination is that principle of our art, which requires us to give to the parts of our designs their appropriate size; for instance, to the several apartments, sufficient area for the purposes to which they are dedicated, without making them disproportionately large for the whole structure. It requires us to give to our doorways, corridors, stairs, etc., sufficient width; to our windows sufficient size for the requisite supply of light; and to our walls and other supports, sufficient thickness or strength.

There is, however, one difficulty to be met. The term *ordinatio* seems rather to express arrangement, than adjustment of size. How, then, does it admit of such an interpretation as we have given it?

We must here, in the first place, observe, that as Vitruvius professes to derive his knowledge from Greece, so he employs all Greek terms; and it is therefore to Greece that we must look for a solution of the question. Now the term *ordinatio* he explains by τάξις, which is no doubt the original word, of which *ordinatio* is a correct translation. Both express the marshalling or setting in array of an army. And here we must not forget the difference between ancient and modern warfare; in the former of which success depended more on the courage, prowess, and martial eloquence of the generals, and in the latter upon their skill.

The tactics of Grecian warfare were particularly simple. The troops of the several states were drawn up under their respective leader; but nearly, or quite, in a straight line; and the whole issue trusted to a single onset. With little or no cavalry, and no chariots or elephants, their battles elicited none of the manœuvres, which the use of gunpowder, and especially artillery, has given rise to in modern times. The disposition of an army involved but little idea of arrangement: the chief points were, to bring all the forces into the field; to marshal the natural divisions under their officers; and the general's skill was displayed in apportioning his troops to the several departments of the field. In forming them in a phalanx, fifteen or twenty deep, to make the attack, or in a line to receive it; in determining that his ἔμβελον or κοιλέμβολον, his πλινθίον or πύργος, should consist of so many λόχοι or τάξαι, his phalanx be ὀρθία or πλαγία, as circumstances seemed to require. So an Architect's skill in ordination, consists in apportioning a given space and amount to the several uses involved in drawing out, as it were, before him, a muster-roll of the several apartments and other necessary parts in due order, according to their several stations and importance in relation to the whole.

Or, if we imagine the terms to be employed only in their general acceptation, of setting in order, without reference to an army, the parts of a building may be said to be set in order without reference to actual location, when the most important is made the largest, and the next in importance is also next in size, and so on, in regular gradation; in which also there seems to be some similarity to the form and subordination of an army.

The second principle enumerated by Vitruvius, Disposition, and the Greek διάθεσις, both have exactly the same meaning, viz., the placing in order according to some given system of classification, or, as Vitruvius here defines it, "the just collocation of the parts, and the desirable effect in the composition of the work with regard to quality." As, then, ordination gives us the sizes according to their uses, so disposition teaches us how to place them together, both according to their use (*apta collocatio*) and the general effect in the composition. This term, Mr. Gwilt translates "arrangement"; but as that is mostly applied to the construction of the plan, and Vitruvius goes on to show that he means every species of collocation, I prefer the more general term of disposition.

Eurithmy, the third division, Vitruvius says, is "the graceful form and suitable appearance in the composition (or compounding) of the parts"; and is realized, he adds, when the members are of a height suitable to their width, and a breadth proportioned to their length; and, in short, when all things accord to their own proper proportion.

"So Symmetry (the fourth), he adds, "is the proper harmony of the members of the work itself, and the agreement of any given one of the several parts with the appearance of the whole"; where the words *ipsius operis*, and *universæ figuræ*, are evidently opposed to the word *membrorum* in the definition of eurithmy. And yet so little has this part been understood, that I have not been able to find any one translation in which it is properly rendered, and the distinction maintained.

Barbaro, though he translates correctly the last clause of the definition of eurithm, *omnia respondeant suæ symmetriæ*, which

is generally construed as though it were *universæ symmetriæ*, "the proportion of the whole", but which he renders "ogni cosa risponda al suo compartimento proprio", yet confounds the whole by a note, in which he says, "symmetry is the beauty of order or ordinance, as eurithmy is of disposition"; whereas neither one nor other of them have anything whatever to do with disposition or location of any kind.

Perrault considers eurithmy and symmetry as synonymous, and translates them "eurithmie ou proportion", adding, in a note, that all previous commentators had thought *eurithmia* and *symmetria* as distinct, because they seemed to have different definitions, whereas, in reality, they were one and the same.

Galiani has fallen into an equally remarkable error. He has confounded the Latin *compositio* and *dispositio;* and has expressly stated in a note, that eurithmy means the equal distribution of the members of an edifice, so as to produce a pleasing effect, especially making the left-hand side accord with the right.

In like manner, Mr. Gwilt translates *symmetria* "uniformity", evidently misled by the authorities above quoted.

Newton has had a pretty just conception of the distinction, for he says in a note, *eurithmia* seems to refer to the proportion of a member in itself; *symmetria* to the relation of proportion of the members to each other and to the whole: yet, strange to say, he adds, "they are very similar", and then renders the text in the usual and corrupt manner, translating *suæ symmetriæ* "to the symmetry of the whole"; adding in his comment, that eurithmy is "the agreement of parts with each other and with the whole"; which is exactly the only sense that can be put upon his rendering of the definition of symmetry, except that he there interpolates the word "same".

Our only other translator (Jos. Gwilt) renders the former of these two definitions very nearly as does Newton; and for the latter he furnishes a fresh definition, so as to suit the new sense he has given to the word *symmetria.*

It seems, indeed, that the whole of the confusion above noticed, has arisen from forgetting that every member has at least two dimensions which must bear certain relations to each other, as well as to the whole of the composition; an error which would have been at once corrected, had the word *compositionibus* been translated as a substantive, which it is, instead of as a gerund, which it is not. The former construction shows clearly that the author had reference to the composing or forming of the members out of their fundamental parts of height, width, and length, as a chemical compound is formed out of its simples.

This, it is evident, is the meaning of Vitruvius, by the term eurithmy. As he defines it, it is applicable only to the ratios of the several dimensions of one member or part, whether it be the width and height of a façade, a door, window, or other feature; or the relation of the length, width, and height of an apartment: the depth and projection of a cornice; the diameter and height of a column, etc. That this is the sense in which Vitruvius employs the term is clear; for this is secured, he says, when the members are of a height suitable to their breadth, of a breadth suitable to their length, and, in fact, when all things answer to their own proportion or symmetry,—a passage where the word *symmetria* is used in a general sense, for it is not to be supposed that he would explain one of his six principles by another.

Hence it appears how utterly unfounded is the idea of those writers, who state, that either of these terms signifies the equal and similar distribution of the parts, on the right and left of the centre. Were any argument necessary to show this falsity, it is furnished by the fact, that about one-half of those who find this principle laid down by Vitruvius, discover it in the word eurithmia, and the other half in symmetria. Hence we might naturally infer, that it is justly discoverable in neither.

In like manner, then, as eurithmy regards the relations of the dimensions of any single member, symmetry refers to the relations of one member to another, or of any given dimension of one member to the corresponding dimension of another. Eurithmic proportion exists between the height of a column and its diameter; symmetric, between the height of a column and the height of the entablature, and also between the diameter of the column and the width of the intercolumn. Eurithmic, between the width and height of a door or of a window; symmetric, between the door as a whole and the window as a whole, or between the widths and the heights of the two respectively: eurithmic, between the length and height of the whole façade; symmetric, between the centre and wings, and between either of these and the whole façade, and so on.

The expression "in good proportion" is therefore either very extensive or very indefinite; for it either means that the thing spoken of is in good proportion, both as a whole, and also as a part of a whole, or else it does not express of which nature is the proportion approved, whether eurithmic or symmetric.

That *symmetria* has nothing to do with location, is clear from its derivation, which as plainly expresses the comparison of one thing with another, in respect of magnitude, as it is possible for words to express: literally, it is "a measuring together", or one against the other, as if to determine which were the greater. Some have been misled by our author employing the members of the human figure to exemplify his definition; arguing that as they are set uniformly one opposite to the fellow, that was what Vitruvius meant. If so, he would have used the plural number, and repeated the preposition, and said, as in the human body the hands, feet, etc., are symmetrical, so in perfect works, etc. But not so: his language is, *ut in hominis corpore e cubito, pede, palmo, digito, cæterisque partibus symmetros est*, etc., *i.e.*, as between the cubit, foot, palm, and finger—measures taken from the human body, there exists a symmetry of proportion, so is it in perfect works. Besides, the *digitus* is not properly said to be uniformly placed, unless the uniformity is stated to exist on the two hands, and not on the one.

And again, he goes on to specify certain measures, such as the diameter of a column, the triglyph, etc., which determine the dimensions of all other parts of the composition in which they occur: so that he clearly establishes two kinds of proportion, eurithmic and symmetric.

The fifth element of architectural design which our author lays down, is *decor*, or Fitness, by Newton translated "propriety", and by Gwilt, "consistency". He defines it as "a correct aspect of a work composed of parts, approved with the sanction of precedent or authority." This, he says, is three-fold, according to the grounds upon which it proceeds, whether that be of what he calls *statio*, or of custom, or of nature. The first of these has been variously translated: station, Newton calls it; and Gwilt, circumstance: Barbaro, stanza; Orsini, abitazione; Martin, situation d'un lieu; Perrault, état des choses; and Galiani, statuto. Vitruvius explains it by the Greek θεματισμός, from θεματίζω, to lay down a fundamental principle. For instance, he says, temples to Minerva, Mars, and Hercules, should be Doric, because, owing to the stern attributes of those deities, their shrines should be without delicate enrichments; but temples to Venus, Flora, etc., should be Corinthian, in accordance with the tender nature of these divinities. Here it would seem that the fundamental principle that required to be laid down was the distinctive attribute of the deity to whom the temple was to be dedicated, and which, being known, the style of the composition would be determined. Here we may observe that considerable latitude was left for selection; for, according to the exact aspect under which the deity or object of the erection was contemplated, so the style would be varied. Thus, at Athens, to Minerva, as the goddess of war, the Parthenon, of the Doric order, is dedicated; but to the same divinity, regarded as the tutelary deity of the city, the promoter of peace, and the protector of arts, a temple of decorative Ionic order is erected.

Conventional propriety, or *consistency as regards custom*, requires that established usages, which have been approved in all ages, should not be infringed; for instance, that triglyphs should be introduced in no other order but the Doric; and again, that dentils be not admitted into the Doric. The other illustration

given by Vitruvius of conventional propriety, viz., that magnificent internal structures should be approached by spacious and elegant vestibules, might perhaps appear more appropriate to his third division, viz., natural propriety. But, in fact, this latter refers only to external nature, *decor naturalis* Vitruvius calls it, which every Latin scholar knows is not synonymous with natural decor, but is that which requires the structure to be judiciously located, and arranged with respect to the natural objects, phenomena, or peculiarities by which it is surrounded; for instance, aspects, healthy or appropriate localities, and the like. But the consistency of styles alluded to, depends upon association of ideas, which results from experience or habit, and is, therefore, appropriately ranged under the second division.

The sixth and last principle that he establishes is DISTRIBUTION, explained by him as "an advantageous use of the materials and site, and a frugal expenditure in the execution." Most of the commentators have imagined that because their author proceeds at once to give certain advice respecting economy in materials, that this is mainly or solely the object of *distributio*. But if a little more consideration were devoted to the Greek term, which we must insist upon regarding as the true original, we should more clearly arrive at his meaning. The Greek word is *οικονομια*, a term which expresses the entire control and arrangement, not only of the household affairs, but of the whole estate and its resources, and is more nearly rendered by our word "stewardship" than by any other in our language. Now, as in a Greek establishment it was the office of the *œconomos* to provide for all the requirements of the family and of the estate, and yet to husband the resources, so it is the province of architecture, under this aspect, to furnish all the requisite parts of the design (without lavish expenditure), in such manner and measure as may best accord with the circumstances of the case. *Ὀικονομία*, therefore, as a scientific term, was particularly appropriate, and very judiciously introduced by our author, as explanatory of his Latin word, which, though the nearest translation his language afforded, is by no means adequate to express the force of the original.

It seems, then, that according to Vitruvius, the principles of architectural design are—ORDINATION, by which the parts are made of a size appropriate to their use; DISPOSITION, by which they are placed in convenient and effective collocation; EURITHMY, or the due adjustment of the parts in themselves; SYMMETRY, or the unity of proportion between all the parts and the whole; FITNESS, or propriety, or consistency; and DISTRIBUTION, or economical provision of the essential requisites.

Sir Henry Wotton, as already stated, considered that ordination and disposition were redundant in this explication. But if we have properly understood them, all the parts of a design might be well proportioned in themselves, and a unity of proportion might run through them all; they might also be consistent as regards appropriateness of style to the object proposed, custom, and external nature; and every requisite might also be furnished without inordinate expense: and yet, if ordination were neglected, some of the parts would be too small for their use, in proportion to the general scale, and others larger than necessary; or the parts might even be correct in these respects, and yet, unless disposition were studied, be inconveniently contrived, or so arranged as to produce a clumsy or weak effect.

Nor, on the other hand, was Perrault more correct, when he supposed that if ordination and disposition were properly attended to, all other requisites must necessarily be secured. For an edifice might be very convenient, both in respect of the magnitude and arrangement of its parts, which might in the essential dimensions be proportioned to their uses and the general scale, and the effect arising from arrangement be the best they admitted of; yet the apartments, though of sufficient area, might be too low or too long for their width to be elegant or noble; sufficient light might be admitted at very ill-proportioned windows; the entrance, though wide enough, might be inelegantly low, or absurdly high; the vestibule, though large enough for useful purposes, and appropriately situated, yet not consistent with the spacious saloons; or the design might be correct in all the above particulars, and yet be abundantly too expensive for execution, or when executed, useless, because, forsooth, there was no staircase to the upper floor, or, if a palace, no state rooms in which to hold the levees.

In like manner, the ordination, disposition, consistency, and distribution, may be perfect; and there may be also unity of proportion, but that very clumsy or very weak; or the proportions of eurithmy may be very good, and yet one part of the edifice in Doric tone, and another in Ionic, and a third Corinthian. And so, were we to ring the changes, we should not find one of these six elements with which we could dispense.

On the other hand, that design, which provides all the essential requisites, so far as expense and circumstances will admit, thereby fixing the general scale of the composition; which proportions their sizes to their uses on this general scale; and which arranges them in the most convenient manner, is complete in the *utile;* and if it also affixes graceful proportions to all these parts, and entwines them with a oneness of ratios, so far as is consistent with their usefulness, and then places these graceful parts in good relative positions, maintaining consistency throughout; such, we say, is a perfect design, so far as art can make it. That it may be clever, good, beautiful, or deserve any of the other hackneyed epithets, we do not assert. This depends not upon education, but upon talent; not upon acquired, but upon natural, power in the designer.

This analysis of the theory of Vitruvius is, therefore, not only correct, but also visibly exhibits all the elements of the compound, and the order in which they are placed is just and natural. First, the parts are procured of appropriate size; then justly arranged as to convenience and effect, which, as there can be only one arrangement, must be a single act; but this must be done with reference to eurithmy, both as regards ordination and disposition, and these must again be adjusted according to symmetry. Next, we must see that the consistencies are maintained; and, lastly, that everything essential is provided, and not too much expense incurred. The only doubt that can exist, is whether distribution should not come first; for ordination, disposition, eurithmy, and symmetry, must of necessity come together, and *decor*, or consistency, as a restriction, follow. But as distribution is, after all, the grand restrictive clause, it very properly accompanies *decor*, and with equal consistency closes the catalogue.

If this be so, then, as far as the limits of a paper like the present will allow, I have succeeded in making good my original proposition, or, at all events, in showing that in this case, at least, the text of Vitruvius is not "sophistical twaddle", as it has been called, "put together by an ignorant compiler, who scarcely possessed the most crude and childish notions on the subject treated of." I have endeavoured to show that it is an admirable explication of the subject when elicited, in all the views in which it can be regarded. True, it is not easy to make it out, on account of its minute sub-division and subtle analysis, — a characteristic feature of Greek philosophy and metaphysics,—as well as from the absence in ourselves of a like methodical investigation of the operations of the mind, which leaves us unprepared to appreciate its fitness. It is the original of every similar attempt, but equalled by none; and the author, whoever he was, is worthy of our highest admiration, entitled to our warmest thanks.

WILLIAM WILLMER POCOCK, B.A.

THE PRINCIPLES AND PRACTICE

OF

ARCHITECTURAL DESIGN.

One of the fundamental principles in architectural design is perfect adaptation to the purpose intended. It is this purpose which originates the building; and it is only by a strict and uncompromising regard to the full provision, and to the perfect adjustment, of the various conveniences required, that an architect can be said to put himself under that self control and discipline, which are necessary to insure a satisfactory result to his subsequent operations in the more artistic features of his design. Superficial display is a dangerous attraction for the artist; and he should, therefore, the more scrupulously respect those considerations which conduce to substantial reality.

The connexion of the constructive, with the exhibitory, features of a fine building is not less intimate than that, which exists between the mechanical perfection of the skeleton and the "form divine", of the complete man. The imperative laws of practical truth must chasten and inform the lively impulses of poetic fancy; for the separation of the "utile" from the "dulce", by regarding them as wholly distinct in their nature, is a vulgar and pernicious fallacy.

Where truth exists, the poetical enunciation of it involves additional truth; and where a perfect adaptation to purposes of utility is found, grace of superadded ornament is the more useful. Thus the sole consideration of this fundamental principle, without any reference whatever to decorative application, will go far to create the beauty which constitutes a building a piece of art. Since a design, in which the component parts are rendered duly subordinate and conducive to the best interests of the whole, will exhibit a necessarily induced form and a serial proportion, satisfactory to the eye of intelligence, though the ornate features be not yet applied, nor the exact appropriation of the structure positively declared. In short, the designer may rest assured that a building, honestly and thoroughly considered in respect to its plans and sections, will suggest those elements of expressive decoration, which, consistently cultivated, cannot fail to produce elevations of dignity and beauty.

In illustration of the inseparable connexion between the "utile" and the "dulce", it will be observed, that the mention of this fundamental principle gives rise, as it were spontaneously, to the anticipation of the other, which is secondary only in the order of succession. It must not, for a moment, be supposed, that the artistic properties of architectural design are inferior in importance; it is merely urged, that the utilitarian portion of the architect's labour should be thoroughly and independently worked out in the first place,—that the skeleton and substantial body should be framed and formed before features, which give grace and expression, are at all considered. Knowing that the artistic process is to come, or rather that it waits his coming, the architect must not anticipate what bides its time in patient dignity. The thought of it must not disturb —much less distract—the strictly regular progress of his work; he must act as if the operation might be arrested at the consummating point of mere practical utility. The builder-architect has to yield into the hands of the artist-architect a simple model, perfect in its general form, arrangement, and construction. In other words, the same mind has to exert all its best powers of practical ingenuity and science, before it gives the rein to imagination and taste.

The other fundamental principle of architectural design is perfect adaptation of decorative features to the carcase, of which they form the superficial grace, and to which they are simply intended to give artistic expression. These features are in no respect to be applied to the building, as things having a distinct and separate existence; but they are to be confined to such a display as may be suggested by the character and formation of the building; a superinduced result, owning to the parentage or willing adoption of the substance on which they are to be formed. The matter of the argument is already produced; its logical arrangement is decided on; its general conclusions are formed; it is substantially perfect as a piece of reasoning; and wants only the graces of art.

The process, involved in the secondary principle, is to invest the subject with beauty of diction, with poetic illustration, and with the charms of rhetoric. As in the first instance, the artist was true to necessity; so in the second, he must be true to permission. The construction of the machine is complete in respect to its bones, its sinews, its covering, and general form: there is now a sufficient latitude allowed to the imagination, in giving to it a suitable complexion, and in gracing its essential and varied parts with features of ornate and distinctive character. What the skin is to the body, the hair to the head, the eye-brows and lashes to the eyes, and the lips to the mouth,—such is the marble casing to the walls, the cornice to the façade, the pediment and architrave to the windows, and the porch to the door. Nor is the architect wholly restricted to such appliances; as the painter and the sculptor are at liberty to employ such accessories as advance the significance or dignity of their productions, so the architect may make use, to a certain amount, of features, not essential to the perfection of his building critically considered, but still admissible as suggesting some sentiment connected with its individual peculiarities. Thus the sacred temple, perfect in its fitness and in the architectural expression of its solemn purpose, may yet, without detriment to this critical excellence, be characterised by an extrinsic splendour, having reference to the sacrificial devotion of an offering to the Deity. The palace, complete in its convenience, arrangement, and consequent architectural presentment, may yet exhibit increased gorgeousness, typical of the pomp which waits on regal state. The city-hall, a model of its kind as a piece of sterling architecture, may yet be rendered of more interest by such additions as call to mind municipal importance, festive bounty, and commercial wealth.

Indeed all buildings, of whatever kind and degree, are, in addition to their merits, as finished pieces of architecture, susceptible of certain congruent and expressive graces, as works of art in the more general sense of the term. The sculptor and the carver of ornate symbolism may be called in, even at the end of the eleventh hour, to carry out the ultra-final conceptions of the architect in the further "illumination" of his work. But it must be observed, that this is a most delicate operation, to be ventured upon only by those who have arrived at this perfection by the most scrupulous gradations of experience. It is the last to be thought of, as well as the last to be done: it rests upon an hundred foregone and successive permissions; and is the ultimate privilege of an imagination, so self-castigated from the first, that an habitual preventive of excess has been thoroughly insured.

According to the value, of these two principles, it will appear that the primary consideration governing the architect will be the exercise of that sagacity, which, in some degree at least, is common to all men; and which, when exercised in this particular calling, will enable him, without regard to any known style of architecture, or any conventional forms, to arrange his walls, partitions, coverings, and openings, in the manner most conducive to the required capacity, convenience, shelter, light, ingress, and egress. Nothing that he now does should have reference to any particular anticipation; for to start with yearning thoughts of a portico, dome, or mediæval model, for every subject, is to stumble at the threshold. The only promise, to which he may now bind himself, is to do the best he can for the purpose placed under his care. He may, hereafter, go to the past for classic, gothic, or other ancient details or features; but he is now to think only of walls, with openings in them for doors and windows; posts and beams, or piers and arches; vaults of brick, or roofs of wood; such decidedly essential parts, in short, as constitute what may be termed the aboriginal forms and combinations,—the materials of legitimate design.

The best arrangement of plan will first demand his most serious attention; and this will give a fixed ground-outline, from which to raise the vertical planes of the elevation. The necessities of construction will then equally demand his care; and these will induce certain sectional forms, varying with the material which circumstances may render more or less absolute. Plan, section, and elevation, will be subsequently modified into that equality of concession, which may leave the general body of the structure as perfect as man's imperfect ability may hope to make it.

The secondary consideration governing the architect, and one which is more peculiar to himself, will be the adoption or modification of some style of architectural decoration, or the employment of some new (and more appropriate) manner of ornamenting the surface of his edifice. He will now bring into operation,—not a servile obedience to limited attainment and partial precedent, but—a free exercise of that adaptive and inventive intelligence, which results from the unrestricted cultivation of general knowledge and of an universal acquaintance with varied examples. He has not been, hitherto, working up his rough model to receive any prescribed manner of architectural finish; but, on the contrary, he has bound himself to such a "finish" as the independent requirements of his rough model shall demand. The yet unadorned structure is to be honoured as the parent of the future ornate piece of architecture; and, if the latter strictly and truthfully reveal the character of its original, its durability will be insured, and its worth will be acknowledged by posterity. It is possible that the architect may be thrown wholly on his inventive resources, in which case he will make no further use of precedent than the Greek architect did of Egyptian Thebes; i.e., he will improve on certain sentiments of declaratory power or expressive beauty, as shewn in the olden appreciation of majestic simplicity or suitable decoration,—but he will seek in his own disciplined imagination for those details of ornate expression which are to produce parallel—but not similar—effects.

The architect's early studies, therefore, are intended for the education of his mind, and not for the dogmatic guidance of his practice; and the more extended those studies,—the more general his intimacy with Egyptian, Greek, Italian, Byzantine, Arab, and Mediæval art, the less will he acquire a prejudiced partiality for any particular variety. He will study rather the principles which are common to them all, than the forms and features which are peculiar to any one of them singly; and he will find that the true spirit of imitation may be more devotedly shown, in emulating the independent and inventive genius of those, who have distinguished themselves in separate styles, than by the practice of a bigoted system of copyism. At the same time, while his invention is stimulated, he will necessarily imbibe the virtue of a modest deference, arising from that reverence, which he cannot but acquire in his "worship of the great of old".

Matured in themselves, as may be the great specimens of art, which illustrate the successive epochs from the date of Thebes to that of York Minster, there may still be requirements, demanding forms and features which are imperfectly, or not at all, supplied by existing or recorded examples; and the dictum, which imperatively prescribes that any desired new building shall be in the certain style of a bygone period, is simply one which demands the production of an academical "exercise", a mere school theme, for which even dulness may "cram" itself, and which will leave laborious book-knowledge to triumph over inventive genius. The amateur advertiser, if he mean more than such an exercise, has assumed to himself, in the first instance, a right of selection for which he is unqualified; and he has promised himself, in the second place, the exercise of a judgment which he is not competent to form. He cannot know so much, without knowing more; and it were better that he should consult the interests of art, by himself doing that, which he has too condescendingly invited the architect to do for him. He may be (if an intelligent, an accomplished, and unprejudiced man) competent to judge between two designs made by two wholly unfettered architects; but, if he has begun by prescribing a favourite style of his own, he can only end by deciding in favour of that which approximates to his own peculiar notions; assuming, in short, the questionable privilege of judging in his own personal cause.

One of the most absurd of prevalent fallacies, is the right asserted by all parties of pronouncing on matters of taste: as if matters of taste were matters of superficial whim, idiosyncrasies of a constitutional fancy, having reference to things of an entirely separate and individual existence, apart from those matters of substance on which they are to be exercised, and from which alone they derive their vitality as matters of worth. He, who has designed and constructed the building, ought to be the best judge of those more superficial appliances which come within the province of taste; since there can be no good architectural taste which is not expressive of, or suitable to, the feelings and purpose, which have governed the designer in the general form and construction of his model.

A piece of architecture, though it be private property, is yet a public object. No other works of art proclaim themselves so openly to the world; and it is the duty, even of the most freeborn Englishman, to eschew the ostentatious exhibition of a mere personal manifesto. If freedom be, as Hartley Coleridge says, "a universal license to be good", the sentiment applies not less to correctness of taste than to propriety of morals. He, who rears an imposing façade, which challenges, and may continue, perhaps for ages, to challenge the admiration of passing thousands, has ventured on a responsibility which concerns the cause of universal license,—i.e., of such license as may be universal, consistently with the sovereign laws of truth.

When architects shall again be architects indeed,—i.e., professors and practisers of certain universally admitted principles, they will teach their critics to estimate that beauty only which is the exponent of truth: but so long as architects shall condescend to

waive their authority as teachers, and to yield, for the sake of pecuniary patronage, to the caprices of individuals, or to the partially informed opinions of incorporated amateurs, they can establish no principles, and impart no catholicity of feeling. They must remain the mere draughtsmen of prejudiced employers, with no hope beyond that of temporary emolument, with no prospect of imperishable fame.

The nation, that would leave monuments to address the sagacity, and claim the homage, of remote posterity, must be unanimous in opinion, at least on national principles, as well as obedient to national requirements. The recognition of these principles and requirements will be, of course, common to the public and to the professor; but the manner of treatment must be left to the professor exclusively. The only combination, which can lead to the desired result of a national architecture, must be that of the associated public,—pronouncing a clear distinct demand for a certain thing of simple and defined purpose,—with the entire professional body, prepared by reflection to answer such demand in the best and most uniform manner. While particular architects are attached to particular bodies of employers, nothing but the unfruitful results of sectarian art can be expected. People chiefly differ when there is nothing very important to agree upon; and they will continue to disagree, so long as the fashion of the thing is determined previous to a decision as to the thing itself. Egyptian, Greek, Byzantine, or Gothic art is great, because all the examples of each are obedient to a supreme national rule. The architects of each variety brought their differing, justly-constituted minds to bear upon the same object; and produced, not repetition, but resemblance; while they still maintained that characteristic individuality, which is to be found in every example of the human form. Man resembles man throughout the world; but no two men were ever yet found exactly alike.

To illustrate the practice of these two principles of architectural design, a particular case may be selected, viz., such as that of a religious edifice, adapted to the ritual of the Church of England, assumed to be built of stone, and covered with a vaulted ceiling; with walls enclosing a space sufficient to accommodate not less than one thousand persons seated, all of whom may distinctly hear and see the officiating minister. A tower is required for the bells, as well as to denote conspicuously the position of the church, whether in the town or in the village. The building must include suitable porches, a spacious entrance, a baptistery, a recess for the communion table, and attached vestry and other needful rooms. No galleries, except an organ-loft, are to be introduced; nor any wood-work, except the internal fittings, the roofs over the vaultings, and the upper floors of the tower. It must be, in every respect, a handsome, consistent, and durable piece of architecture, worthy of its sacred purpose, and aiming at perpetuity. The amount of decoration must be such as circumstances, and the nature of the design, may require; but the building will, of course, derive all its essential beauty and grandeur from the attention bestowed on the general arrangement of its parts, and the nice adjustment of their relative proportions. No pseudo-architecture is to be admitted; nor any ornament but that which may be suitable to positive features, or such symbolical accessories as may give additional expression and richness, without injury to the simplicity and general effect of the mass. There must be no deceptive concealment of required means, nor affectation of necessity, to give a false warrant to imposing objects in the composition.

It will not be necessary to detail the process, with every successive step of reasoning and every modification of thought, by which an architect of independent mind will gradually advance, and ultimately arrive at his conclusively adopted model. To do this would require a book instead of a mere essay, and in place of the few subjoined illustrations, a portfolio of drawings and studied sketches would be necessary. The comments and reflections, which follow, must be regarded as mere starting points in the reasoning process, and the figures must only be viewed as types of ideas in illustration of the argument: but they will suffice to shew the mode in which an architect should experimentalize in composing a design, which may equally evince a regard for his own independence, and his respect for the precedents of antiquity.

It is presumed that, whatever be the form of the auditorium in each variety, the other parts of the building will remain generally the same cubes throughout.

The circular, or polygonal form of auditorium, Fig. 1, will be first considered; containing in its area space for a thousand sittings, which can be well and conveniently arranged, both for sight and hearing. There will unquestionably be much grandeur in the effect of such a rotunda, surmounted, as it must be, by a single vault. Hitherto somewhat of a classic dress has always been adopted for such a cubical mass. The dome within and without will exhibit that expression of majesty, which is displayed by the Pantheon, and there will be nothing unpleasing in the general form of the plan. When the sectional construction and internal proportion have been decided, there results the general external form, which honestly and truthfully deduced may or may not be admitted, to have something that is highly picturesque in the clustering of the parts; but it may also be urged, that the parts are too distinct in their individuality; that it is a combination of separate forms attached to one another, instead of a single form composed of parts contributive to uncomplicated effect; that the high square tower, and the low spherical dome are in rivalry; and that the vertical elongation is in contest with horizontal expanse; which is the principal characteristic of the building! If it be said, "raise the dome to a more suitable external proportion," that cannot be done, since the internal proportion will not allow of increased height: besides, the dome has primary reference to internal effect, and the tower is required by the very term of the instructions to be the external conspicuous object. The sentiment of firmamental expanse is desired within; and additional height will be equivalent to diminished horizontal space.

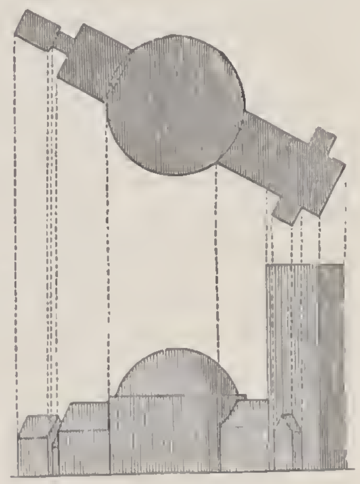


Fig. 1.

Again, the junction on the plan, of the square with the circle must involve an imperfection; a segment of the latter must either be cut off, or it must be permitted intrusively to its attached squares. A remedy is obtained by adopting the octagonal form. Still the wide swelling dome will, in its close neighbourhood to the tower, look like a crouching giant by the side of an erect one; thus there are two giants; one only is required, and even that should not be the tower or the dome, but the entire building. The vertical altitude of a tower, balanced by the horizontal length of the attached body of a church, may exhibit a distinction without a difference; elongation is common to both, and unites both into one whole: but there exists vertical continuity and horizontal interruption; the glassy surface of the waterfall descends to be shattered among the breakers below; or to reverse the action, and vary the simile, the spectator is ever endeavouring to escape from the turmoil below by ascending the rock which rises from it.

In plain language, the main body of the structure is here under such different conditions from the rest, that no continuity of feeling can be preserved. It is, at least, a question whether any skill (consistent with perfect architectural integrity) could prevent the appearance of complication, where unity is the great desideratum. A form must be found, which shall comprise internal advantages, of convenience and beauty, equal to those of the circle or octagon, with a corresponding amount of external propriety.

The perfect square Fig. 2, may be taken next as the outline of the required auditorium. Its capacity is, of course, made equal

to that of the circle or octagon; but instead of the dome springing from a polygonal or circular tambour, its quadrangular area is to be covered with a vault; and in lieu of a continuous abutment, dispersed equally through the uniform substance of the supporting inclosure, the pressure of the vault must now be concentrated on four distinct abutments, one at each angle of the square. The internal result of this disposition is susceptible of being rendered impressive. The exterior of the main body, if in the Classic or Italian styles, may present four great gables or pediments: but it becomes too box-like; though it will perhaps be admitted that the effect of the whole is more harmonious than in the first example, and that there is a breadth in the contrasting light and shade which tells powerfully. Still the auditorium is too massive in its bulk, and too overwhelming in its relation to the tower, as well as too crushing in respect to its minor adjuncts; the whole presents too decidedly a cluster of distinct portions, abutting each against another. What it gains, externally, over the former model, it loses internally; and we may perhaps regard the result of the contest between them as undecided.

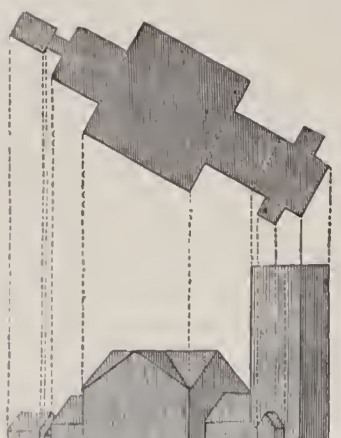


Fig. 2.

The next suggested form for the main body of the edifice, is that of the rectangled parallelogram of the Romanesque period, Fig. 3; to be covered with a continuous "waggon-headed" vault, or with a series of groined vaultings. If the former exceed a certain length it will appear tunnel-like. If the latter be employed there must be, at least, three bays or openings, for a pier is never admissible where it is obviously central. Whichever may be taken, a length equal to three bays will be the best for an interior, which is to retain the proportions, of a compromise between length and breadth, i. e. of a room as distinct from a gallery. In following out, from the required area, the regular process of the resultant section and elevation, a cubical mass is obtained, not so distinguished by breadth of shadow as the last attempt, but, critically considered, of a better general form; leaving the tower the supreme external feature, as it should be, so far as it may, consistently with its being only a part of a harmonious whole. If the waggon-headed vault be employed, the side walls must, of course, be thick; but if groined vaulting be adopted, the projecting external buttress is the consequence; and the assistant pier may project within the building, so far as it can be allowed without detriment to sight and hearing. But the employment of these vertical features so corrects the horizontal length of the main body of the structure, that its extension is immediately suggested; and the employment of the buttress and pier, (which may be chosen to afford increased opportunity for perspective effect) having been decided on, it is clear that, to a certain extent, the proportions of a gallery may be taken for the auditorium, a truth which the Gothic architects clearly perceived and established.

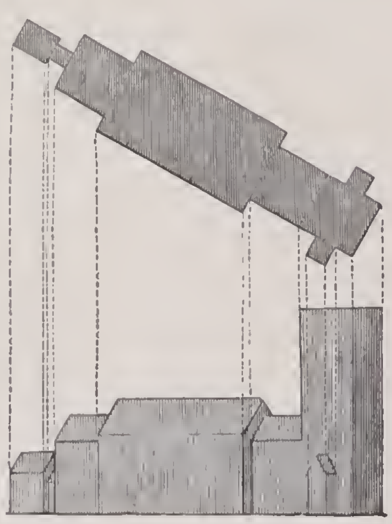


Fig. 3.

The parallelogram is next, therefore, narrowed and elongated, so as to include the required area within its walls as before, Fig. 4. It is now obviously improved by the diminished span of the vaulting; but there is (or the artist has learned to consider there is) a certain required proportion between the width and the height of a semicircular vault or arch, which is now interfered with. The pier looks too high; the crowning cylindrical vault springs from stilts; it becomes so fore-shortened that it seems flat; but though width is resigned, height cannot be forfeited and it is therefore desirable to lower the springing of the arches. The long and narrow half of an ellipsis may be tried; it is not pleasing; it expresses a checked aspiration. The pointed arch is satisfactory, as it expresses infinite ascent; for a perspective of parallels may be so elongated as to present in appearance a a distant point. Length and height have now become the theme, as opposed to expanse: the rich perspective fascinates: still such a continuous length of sameness must be regretted; and when the building is viewed externally, on looking more directly against its elongated side, it lacks the picturesqueness of varied mass; there are too many strips of shadow; breadth of shadow is required, which the tower alone exhibits in the aspect chosen, while more planes of dark are wanted to contrast with planes of light. The building also is still, in a measure, a range of distinct blocks. The tower is with the rest, rather than of the rest.

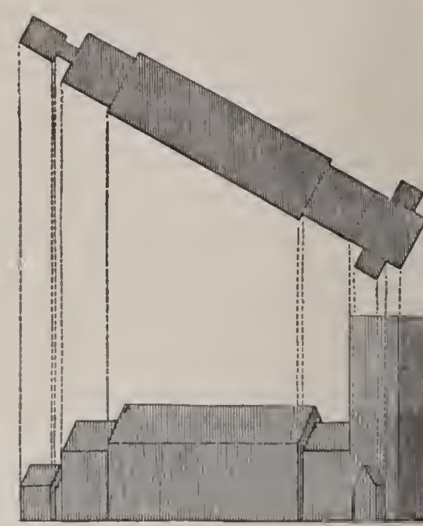


Fig. 4.

The width of the main body of the building is next reduced, so as to make the ridge of the roof and the range of the parapet continuous with those of the baptistery and of the recess for the communion table: but of course, if the last plan be preserved, the evil of disunion is only corrected by increasing the above mentioned defect, "the continuous length of sameness". This brings on a most important change of form; a change which no precedent was required to suggest, but which, happily, precedent is ready to justify. The idea of the cruciform plan, Fig. 5, is, at length deduced. It is found to be suited pre-eminently to the purposes required; a large superficies for sittings is obtained, without great width between the walls, and without too great length from the position of the minister to that of the most distant auditor. Practical convenience is associated with symbolic form. In the former plan a length of eight bays was taken: on that now under consideration, two of these bays are taken from the length, one given to each arm of the cross, to make the transeptal length across the front of the chancel, or recess. The sides of the church have now their gables, as well as the ends; a noble projecting mass gives character, expression, and picturesque boldness to each side of the building; for now there are three distinct (but perfectly united) features in the nave, the transept, and the chancel; while the whole body to a certain extent is decidedly one. But, to improve still further and to render the building more comprehensive in unity, the crowning triumph yet remains. The tower needs no longer be a thing attached; it becomes the cognate member of an undivided whole, springing as legitimately from the square of intersection, as a truthful deduction does from philosophical reasoning on admitted premises. Thus a form is obtained which, so far at least as regards its general shape and mass, is manifestly superior to all the others.

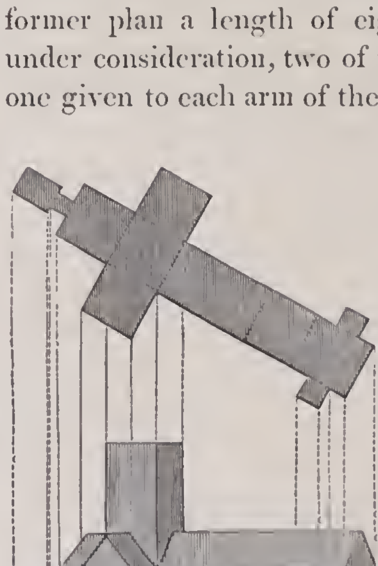


Fig. 5.

The architectural style, which each form suggests or best admits, may now be considered with all possible fairness. The arch and dome are Roman; novelty needs not to be sought for novelty's sake; antiquity, in fully meeting its own wants, anticipated many of ours; and it has left us the cornice, impost, archivolt, column, entablature, and pediment; these are as ap-

propriate to our first model (the circular), as they were to the Roman Pantheon: while the campanili of Italy fulfilled the uses of the Gothic bell-towers. Old forms may be modified, and old details with their application, may be improved; but in a general way they are to be accepted with gratitude and faithfully introduced.

The second, or square form, is equally subject to Italian treatment, though the plan admits of some features which perhaps belong more to the eastern and mediæval, than to the ancient Roman periods. The details of the Palladian, and still more of the modern schools, afford us much that harmonizes with our notions of the antique, and perfectly suits modern requirements.

As the circular vault and arch remain in the third form, that of the parallelogram, the artist is confined to choose his decorative details from the Roman, the Romanesque, or some modification of those styles. The great proportional width continues to enforce the low pediment or gable; buttresses and vertical pressure are required to resist lateral pressure; but buttresses may be Romanized, or, rather, Anglo-Romanized, while the balustrade, with its pedestals, figures, and ornamental vases, may be made to serve the purpose of Gothic buttresses, parapets, and finials.

Rejecting the Romanesque,—not less in its Anglo-Norman, than in its Italian and German form,—and despairing of any original style within modern powers of invention, the architect will recur at once to the pointed arch, as it induces less proportional width, while it occasions higher gables. For decorative details there is abundant precedent in the various mediæval Gothic styles; but it would be ridiculous to refuse the adoption of some variety of that pointed architecture which was brought to such perfection of detail in our English cathedrals. The architect, therefore, can adopt the high pointed, with its simple windows; the pillared and foiled windows of the second variety; the mullioned windows, with the tracery of the third; or the mullioned and transomed work of the fourth period: at all events, he would use a Gothic style in all the decorative features. Having obtained his general model, and deduced the leading forms and members from considerations, wholly independent of bookish theory, and solely referring to the strict purpose and modern character of the building, he may now (creditably to his modesty, and without compromising his inventive freedom), go to a Glossary of Church Architecture, and be as particular in the selected examples of detail, as the most devoted of Diocesan Societies could desire. The most strict observance of the details presented by English ecclesiastical monuments, will still leave his modern church to stand on its own merits as an original. Internal detached arcades, flying buttresses, clerestory and triforium, are utterly discarded; and instead of the triple combination of nave and aisles with two ranges of windows, there is now one lofty single nave, lighted by a single range of windows. Such a design, it cannot be denied, simple and plain though it may be, will present a more decided character of unity than either of the three preceding combinations.

But the union is not perfect; it is still a conjunction of separable cubes, far inferior in effect to the Gothic decoration of the model last to be considered, namely, the cruciform. Here the architect can lessen the projection of the buttresses by reducing the width of the vaulting; and can reduce them further, by adopting the vertical weight of the pinnacle. The use of the latter at once suggests (because it justifies) the adoption of the spire. If the pointed style be carried out, he has the idea of a Gothic church, for modern use; perfect in its unity; challenging further advance; from which nothing essential can be taken; to which nothing essential can be added; the sides of which have a nobler elevation than the church with aisles can ever have; the steeple of which emerges, as if naturally, from its cruciform substructure, the whole majestically rising pyramidically from the expanded and varied outline of its base, at once simple, ornate, and expressive of its holy purposes.

It has thus been attempted to explain the operations of the two great principles which should guide the architect, in forming and maturing his design for any building, whatever its use, or whatever style it may induce; and a case in illustration has been given, in which the adoption of the Gothic style has been finally resolved on, from the conviction that it is the most applicable to a modern church of large dimensions, although the latter necessarily differs in some important particulars from the Mediæval model. But the adoption in this one instance is by no means to be construed as advocating the idea of Gothic architecture being suitable to every description of building. On the contrary, it is rather believed that a like application of the same principles, to almost any other purposed design, would lead to an almost absolute rejection of the Gothic style, and to the imperative adoption (subject, of course, to many modifications) of the revived Græco-Roman architecture. The present rage for the numerous quaint Mediæval varieties to be found throughout Europe, is a sign that the true Gothic mania is declining. Already is the feeling for the fine old English architecture giving way to a wild revelling among foreign examples of transitional periods, and the country is positively becoming a mere museum of miscellaneous specimens. Things interesting as illustrations of the past (to be respected in their venerable existence, and worthy of regard in their pictured representation), are seized upon with unthinking avidity, and practically exhibited in brick and stone, as the works of the draughtsman successively issue from the publisher. What should remain in books, rises in form palpable to feeling as to sight. What should only operate to the establishment of "principles", stimulates to activity in the idealess work of unprincipled imitation. Instead of the results of general information, each architect gives a servile example of his partial knowledge, leaving the public to revel in a licentious multiplicity of bewildering varieties. Just as the conflicts between the ancient systems of philosophy produced no truly philosophical result, so the modern clash of architectural fancies brings forth no architectural truth. Some architectural BACON is required to supply us with a "Novum Organum", which may teach us, from observation of the past, to deduce wisdom for the present.

An endeavour has been made, in the foregoing observations, to indicate at least such a process of thought, experiment, and deduction, as might, if universally followed, give rise to a system of national architecture; an architecture of several varieties, which would still be pleasingly and expressively associative. But where shall we now find any orderly association or expressive individuality? Instead of the combination of different objects, each marked by its own peculiar features, we see buildings in which purpose is belied and degree confounded. Many churches are only known by their steeples; the palace front is rivalled by the shopkeeper's façade; the manorial residence of the olden style is surpassed in effect by the poor-house; the railway-office may be mistaken for a collegiate institution; infantine ignorance approaches its first teacher under a classic portico, and crime is incarcerated in a baronial castle; liquor is purchased amid Corinthian splendours, and tobacco is retailed, and almost every trade is carried on, in a cabinet gorgeously decorated à la Louis Quinze. Assuredly there is a specialty of rule for each kind and class of building, and an expression of degree suitable to every building individually. By the process followed in determining the form and style best adapted to a church, a canonical decision may be adopted in regard to every other structure.

Of one kind,—to differ only in superficial expression and relative degree,—are the state palaces of royalty; those of the nobility; the senate-house and all other government edifices; all public structures, forensic, civil, and municipal; buildings devoted to the fine arts and polite literature; theatres and other structures appropriated to refined entertainment; club-houses and buildings intended for the social union of the highly educated and wealthy; the mansions of the aristocracy; the residences of the hereditary, the professional, or the merchant

gentry. All these being, more or less, susceptible of imposing scale and ornate stateliness, are enumerated under one class; and for each variety above enumerated, without an exception, mature consideration leads to the assertion, that Græco-Roman forms and details (modified by the Venetian and the recently influential British schools) preeminently claim adoption.

Of the next kind of buildings, are to be reckoned those which, from their nature, are more confined to a simple purpose and a marked expression of necessity. Such are asylums and edifices devoted to charitable purposes; institutes for the educational benefit of the million; gaols, and structures of penal intent; manufactories, warehouses, shops, and all buildings dedicated to the practical operations of commerce, or appropriated as offices or suits of business-chambers. In these the Græco-Roman style would still be considered the one to be employed; but with such a scrupulous rejection of the elaborate and refined delicacies which were admitted in the former case, that a marked distinction should be unmistakeably emphaticized. Nothing of a prominently ornate character is admissible, except where it is obviously expressive of the main purpose of the building. Perhaps a more suitable example cannot be found to illustrate this position than the prison of Newgate; with a somewhat heavier cornice it would be a perfect piece of expressive architecture; nothing Gothic ever exhibited the substantial and hopeless gloom of its square and windowless rusticated masses. The niches near the angles relieve the superficies without penetrating the mystery, and the house of the gaoler just shows that he is himself no prisoner; but the manacles of the gaol porches are intimations that he who becomes a prisoner may expect to remain one.

The third class of structures is wholly connected with the education of those, whose learning and acquirements are to fit them for the important position they may be called on to occupy in the Church, the Senate, on the Bench, at the Bar, or in their magisterial and professional callings; and within this class may be included such official houses and buildings as are closely connected with the Church. If all education should be founded on a religious basis, the future lawyer and doctor of medicine should, for the time, be Christian learners in common with the intended divine. Therefore, as it has been decided that the church should be Gothic, the writer would assert that our colleges shall be Gothic also; or, at least, designed in that modification of the style which, during the reign of the Tudor dynasty, was adopted for the general purposes of building. The parsonage-house and the church-school building should be Gothic, for the sake of harmonizing with the church; and should not even the private chapel, though attached to an Anglo-Venetian palace, be Gothic also?

But in a general sense, excluding the exceptions just allowed, it is maintained that every modification of the Gothic style is utterly unsuited to civil and social buildings. Such buildings, when executed in this "fashion", may be picturesque, but they are essentially inelegant; and the most admired effects are produced by the forced application of features, unnecessary, and often opposed, to comfort and convenience. During the former prevalence of the domestic Gothic style, cleanliness was impossible, comfort seems to have been unknown, and convenience despised; the floor was strewed with rushes, and the wind found a ready admittance through the crannies between the iron casements and the stone mullions. We are now accustomed to carpets which may not be saturated with damps; and we are susceptible of taking cold, which may not be risked by ill-fitting windows. Every architect knows the expedients and contrivances, which are necessary to make Tudor forms compatible with modern feelings; by using internal wood-work to patch up external stone work, and by making lifting sashes look like hinged casements. Gothic architecture, in its severer sense, is only applicable to the church, or to buildings of but one story. Its natural and proper covering is a vault. The pointed arch, perhaps, grew out of the circumstances attendant on groined vaulting; and our reasonings may have shewn that it might have been so produced: but, at all events, true Gothic pointed architecture is constitutionally opposed to a successive series of horizontal floors; and, to sum up the argument in few words, the Tudor square-headed window with the flattened arch, as applied to domestic architecture, is nothing more or less than the transitional step from the pointed Gothic, which was unsuitable, to the horizontal Italian, which was found in every way convenient.

The fourth class of buildings which demands distinct consideration, is that which, in a constructive point of view, comes more directly under the management of the engineer, and in which an imposing simplicity is the great desideratum. London Bridge is admitted to be a signal instance of success in this respect: but what are we to say to the multifarious bizarreries of the railway buildings? Was there, in erecting the various stations and termini, no peculiarly suitable dignity or beauty to be deduced from the forms and necessary construction of a vast shed, with adjoining rooms for busy clerks and hungry travellers? Is not the Halle aux Blés, at Paris, a far better sample of what may be done with Roman, than the Bristol station of what may be accomplished with Gothic, forms?

To the fifth class belong the country residences of the gentry: and what can be more beautiful as an object, or more favourable to a picturesque irregularity of plan and elevation, than the Italian villa, with its cantilevered roof and its lofty Belvidere, its bay and balconied windows, balustraded terraces, and classic accessories of vase and statue? It has all the advantages of the clustered Tudor House, with others peculiar to itself, and of the paramount recommendation of an especial adaptability to our climate. The Tudor and Elizabethan houses derive additional effect, from being built in wooded hollows: but now, no man of sense builds in such situations. The Italian villa is improved by being placed on a wooded acclivity, where every one now desires to build. The choice lies between the sombre quaintness of the former and the cheerful elegance of the latter; and there is no question that, if a wandering stranger should be suddenly confronted by both, he would choose as, in all probability, his more accomplished and trustworthy host, the owner of the Italian villa.

Of the sixth class, is the "cottage of gentility"; its title justified by the art-improved, yet rustic and secluded character of its position. No objection can be made, under such circumstances, to the barge-boarded gable, the thatched roof, the unbarked posts of its verandah, and the semi-Gothic doors and windows.

To the seventh class, belongs the dwelling of the artizan and industrious poor in towns; and to the eighth class, the farm-house and the cottage of the agricultural labourer. In the last two classes, some important improvements are being made; for in these, perhaps, more than in any other, the principles above propounded have been truthfully and studiously acted upon.

It is thought that some model design, preeminently suited to a building of each class, can be conceived. These designs, published in a proper form, would constitute a work worthy of the nation, and such as might speedily occasion a general move towards the ultimate establishment of a national architecture.

George Wightwick.

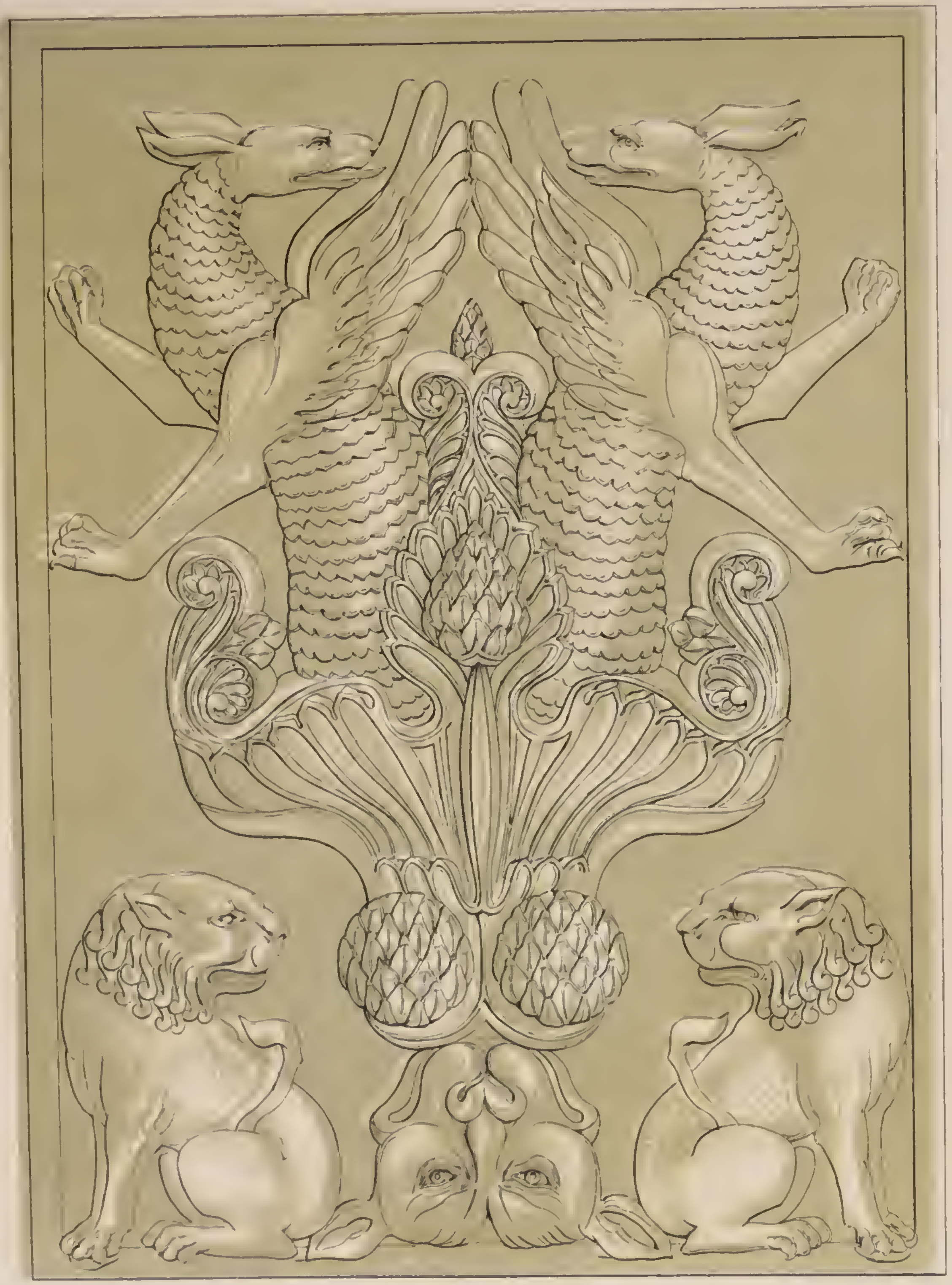
DIAPER

ASSISI

FROM WALL OF UPPER CHURCH OF SAN FRANCESCO 14TH CENTY

SCALE QUARTER FULL SIZE

DOOR

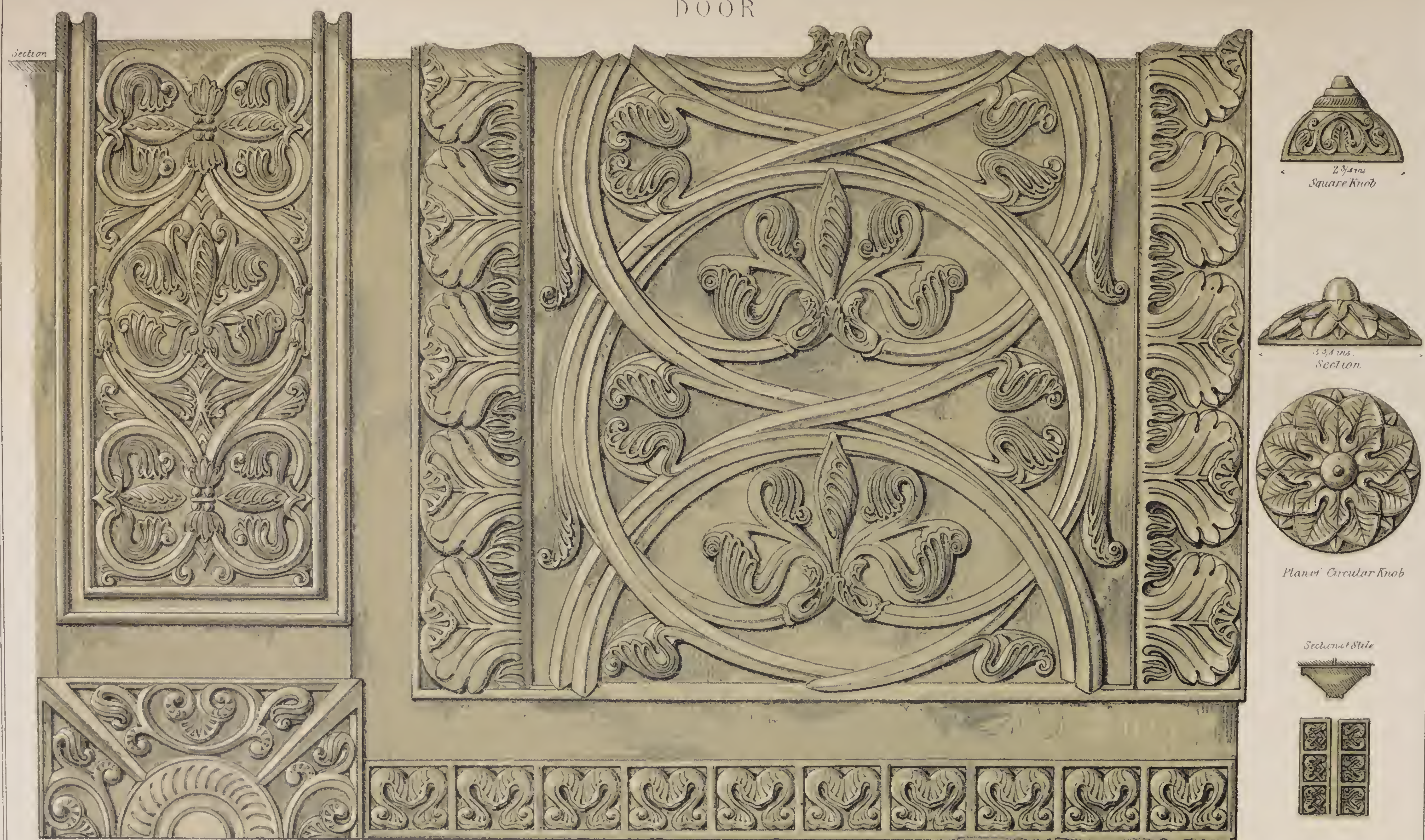


ORNAMENTAL PANEL

CATHEDRAL CHURCH OF S PANTALEONE RAVELLO
([illegible] A D 11[illegible])

Scale
12 6 1 2 3 Feet

DOOR



BRONZE DOORS

CATHEDRAL CHURCH [illegible] S. PANTALEONE, RAVELLO

(117[illegible] A.D.)

DOORWAY.

LORETO

John Davies M I ...

Lithographed by Mess^rs Day & Son. Mar 7^th 1849

DRYING CLOSET.

Plates 70 and 71.

Drying closets are apartments in which heat is applied in various ways, according to the peculiar plan or description of medium adopted, for the purpose of extracting water and other fluids from wet or damp materials by evaporation; a process which enters so largely into domestic and manufacturing arrangements, that a means of drying safely, rapidly, and economically, becomes a serious desideratum.

The importance of the subject will be evident, on mentioning that the manufactures of textile fabrics, linen, cotton, woollen, silk, paper, printing, paper staining, leather, gunpowder, starch, japanning, varnishing, cabinet work, bedding, carpentry, timber, chemical preparations, and many more, all require arrangements which will maintain, or not exceed, a given temperature, to avoid serious injury to the material, and consequent loss to the manufacturer.

At first, a close room was tried, the heat sustained at a high temperature, either by stoves placed within the apartments, or by fires beneath the floor, the latter being of stone or brick. The next improvement was the provision of motion in the air of the room by proper ventilation. A system by which the materials to be dried were subjected to the influence of the heated air, without the necessity of the operators exposing themselves to its deleterious action, was effected by having an apartment, the heat of which was regulated by proper contrivances, provided with an apparatus in which the materials to be dried were hung or fastened, termed "horses", drawing in and out of the room, on rails or tramways. By the application of hot-water apparatus, and the use of steam, much greater precision and safety in the operation have been obtained; and lately, since the institution of public laundries, the necessity for the rapid drying of linen, cottons, and woollens, has called for arrangements of a novel description to effect the object in the least possible time, as those who avail themselves of such institutions, have to pay for the *time* during which they occupy the washing and drying apparatus.

It would appear superfluous to describe the philosophical principles of drying, yet, as it has lately been asserted that it can be effected without ventilation (which is so diametrically opposed to all experience on the subject, that it would scarcely be possible to imagine that such an opinion could be put in print), it appears desirable to give an explanation of the natural process.

The principles on which effective drying depends, are simple and easily understood. Air, even at ordinary temperature, has a great affinity for moisture, and beyond doubt this varies with the electrical state of the atmosphere (which is generally positively, and the air of close rooms negatively, electrical) as well as its hygrometrical condition; this affinity increases as the temperature of the air advances within all known limits;

Air saturated with moisture, in a cubic foot

at 32°	contains 2	grains of moisture.	
,, 48°	,, 4	,,	
,, 60°	,, 6	,,	
,, 68°	,, 8	,,	

(One cubic foot of air absorbs one cubic foot of steam; one cubic foot equal to 527 grains.) The heat maintained must therefore manifestly be greater than that merely required to convert the moisture of the material to be dried into vapour, in order that the affinity of the air for moisture, by adding to its temperature, may be increased; one portion of the caloric is exerted in rendering the water elastic, while the other is enabling the air to dissolve it.

Evaporation may be simply defined, as that process by which liquid is changed into a (gaseous or) aeriform state, by the application of heat. This vapour, at 32° Fah., expands by the application of heat, in the ratio of 1-480th part of its bulk, for every additional degree of heat applied to it. On cooling, it diminishes; if this be continued, as soon as the degree is reached beyond that at which the vapour was generated, it reverts to its liquid state. Evaporation is not affected in its amount by the pressure of air or other gases in the space in which the process is carried on: vapour, to an equal amount, filling a certain space *in vacuo* as easily as when it is occupied with a dense gas; the gaseous bodies only alter the *rate* or *rapidity* of evaporation, not its *amount*.

The space, however, into which the vapour is allowed to expand, exercises an important influence on the rapidity of evaporation; the quantity evaporated is exactly proportional to this. This may be stated in exceedingly plain terms; the larger the vessel the more it will contain; at the *same temperature*, vapour will rise from a body of water sufficient to fill a space of one hundred cubic feet, while it will as duly fill a space of ten cubic feet; but, in the latter case, the same quantity will not be evaporated, unless the temperature and the density of the vapour are correspondingly augmented. By enlarging the space, the rapidity of evaporation is also increased; and the pressure of air exerting no deleterious influence on the production of vapour, and air having an affinity for moisture, it follows that the greater the number of volumes of air admitted near or around an evaporating liquid, the greater will be the amount of that evaporation.

Evaporation is affected only in its rapidity by the presence of air or gaseous bodies surrounding it, and is resisted to a greater degree from this cause than is generally supposed. Thus it was found, that from one square foot of water-surface at a temperature of 90°, the evaporation was twenty-two and a half grains per minute, in a calm; in a moderate breeze, twenty-nine; and in a high wind it rose to thirty-five and a half grains. The point illustrated is explained by the rapid drying of the ground in a windy day, and the speedy evaporation of ether from the surface of the hand, while a current of air is directed upon it, or created by waving it in the air. The same effects may be observed by drying a towel before an open fire; the heat of the fire rapidly drying or rendering elastic the water on the side nearest it, whilst at the back the vapour rises slowly, and may be seen till it passes into the current of the chimney. This is, in fact, the reason why ventilation is considered essential to drying, as each volume of air (which, when dry, has an affinity for moisture, this being increased by raising it in temperature) carries off a certain amount of vapour; it is, therefore, clearly the most reasonable mode to afford a fresh supply of dry air, to take the place of that which is already saturated.

There is an erroneous idea prevalent amongst many, regarding evaporation, which it is here necessary to point out: this is, that no evaporation takes place under 212°, or the boiling

point. This has been truly termed a fallacious opinion; many degrees below the zero of the Fahrenheit thermometer, could it be seen, there is vapour evolved. Mr. Dalton of Manchester, was the first who experimentally investigated, in a minute and satisfactory manner, the principles and rationale of evaporation. From the results obtained he constructed a table, showing "the force of vapour from water in every temperature, from that of congelation of mercury at 40° degrees below zero of Fahrenheit, to 325°." For this table, which will be found extremely useful in all investigations made on applying steam to evaporating purposes, see STEAM, where this part of the subject will be fully discussed.

The new drying closet at the Middlesex Hospital, is six feet wide, seven feet high, eight feet long, and is heated by the direct radiation of the heat produced by the flue of the ironing stove passing through it; by which means it is kept at temperatures varying from 180° to 200° Fahrenheit, with little more fuel than would be required for the working of the ordinary ironing stove. It was originally constructed with an external air drain, but the drying not being satisfactory, the drain was closed, and the following results obtained.

Materials.	Weight when put in.	Weight when taken out.	Water evaporated.	Time in evaporating.	Temperature of the closet when put in.	Temperature of the closet when taken out.
Six blankets	44 lbs.	$23\frac{1}{2}$	$20\frac{1}{2}$	1 hr. 35 min.	200°	160°
Eighteen rugs	169 lbs.	$87\frac{1}{2}$	$81\frac{1}{2}$	1 ,, 35 ,,	200°	160°

The closet, after the linen was taken out, gradually rose to the temperature of 200°. The quantity of fuel required to keep the closet and ironing stove in full work, was found to be about sixteen pounds weight of coke per hour. It will be observed, that the water evaporated from this closet is equal to one pound per minute, and the fuel consumed about one-fourth of the weight of water evaporated. The inference that a change of air in drying closets is not an assistance, but an impediment, is so much at variance with received theory and successful practice, that there must be something in the case which has been overlooked. . . . . A current of air is an important part of the process of drying, perhaps it is as important as heat; for linen may be dried out of doors, where it will be subject to constant change of air about its surface, without artificial heat at all; but if hung in a saturated medium it will not dry, though at a high temperature. Any laundress practising open-air drying, will say that the difference between a good and a bad drying day lies here: in the former, the atmosphere is in brisk motion and dry; in the latter, it is still and moist. In other words, the linen dries most quickly when there is a rapid succession of dry particles passing over its surface. Artificial drying is, in fact, a twofold operation. By heat, the moisture is quickly converted into vapour; by ventilation, that vapour is carried away and replaced with dry air. If no fresh air were introduced, successive changes of wet linen would soon saturate the atmosphere of the closet, at which point drying would altogether cease.—BUILDER, vol. vii, pp. 177, 219, 245, 323.

In the construction of drying closets, every practical man is aware that a large amount of air finds entrance to the closet through the chinks and apertures, which cannot be avoided; this quantity being much larger than is generally supposed. The secret of the success of Mr. Jeakes' closets (the example above-mentioned being one of them) has been, that he has succeeded in proportioning very nicely, the outlet for the volume of *heated air charged with water*, and that the apertures allowed the necessary quantity of air—to be heated—to be admitted. Ventilation may be in excess; because the ingress of too large a quantity of cold air prevents the general temperature being raised to a proper point for promoting effective evaporation. The utmost effect will be obtained for a closet and heating apparatus of a given size, when the air admitted bears a definite and not to be exceeded proportion to the quantity of vapour to be evolved in a given time—to the temperature—to the thickness of the textures—to the state of the atmosphere at the time as regards dryness and motion. Hence there should be area for ingress and egress sufficient for the greater required quantity of drying, under the least favourable state of the external air, with means of reducing that area for smaller quantities under a drier or less stagnant atmosphere.

The peculiar mode of ventilation, hereafter described by Figs. 9, 10, and 11, Plate 1, and followed in several public buildings, has not in any instance failed, and is apparently identical with the operation of that described as fixed at Middlesex Hospital; for although the air drain be rightly abolished, the same closet remains yet perfectly ventilated, and upon exactly the same principle; for although the narrow slit, made for the admission of fresh air, may not be provided specially, yet the steam cannot pass away with a sufficient rapidity, unless influenced so to do by a current of air, passing through the closet, powerful enough by its levity, compared with the external air, to carry or pass such steam away. *A small amount of aperture will, in reality, be sufficient*, when it is considered how much the volume of air admitted to the closet at 60° is expanded during its progress through and out of it, saturated with steam, at 200°; and that this is the operation constantly existing, is evident from a smaller closet heated by hot water in Park Lane, where sliding entrance and exit air-valves were provided in the centre of the floor and ceiling. When both were closed, the wet clothes were invariably rendered hot, but never dry, in twenty minutes; the whole of the steam that did escape finding its way into the laundry: on opening the valves, the lower one (which communicated with a room below), one-fourth of the area of the upper valve, a sufficient current of air was admitted to pass the steam freely away, without much loss of heat, but evidently, from two distinct trials, the establishment of the current was imperative.—BUILDER, vol. vii, p. 339.

Mr. Ashpitel found, in one instance, that a closet of this kind of construction was readily heated to 200°, but the clothes would not dry. In fact, for want of proper supply of dry air and exit for the reek, the water in the clothes rose as vapour, became condensed on the ceiling of the room, and fell back again upon the clothes in the form of a scalding rain, continuing this alternation for hours.

A very positive proof of the fact that wet material would not dry without ventilation, was found at the public laundries of St. Martin's in the Fields; the drying chambers, which are constructed of slate, were made quite air-tight previous to the ventilating apertures being made, and when the heating pipes were set to work the wet articles would not dry, although there was a temperature of 200° at the time; but as soon as the ventilators were opened, the drying was effected rapidly. It is quite possible to be deceived on this head, in experimenting with a drying closet; for notwithstanding there might be no provision made expressly for ventilation, it being unusual to construct closets so accurately as to render them air-tight, air and vapour at high temperatures are so exceedingly elastic, that ventilation would take place at every crevice; and, even if every joint was pasted over with paper, the vapour would most likely find its way through the pores of the wood or paper; and it is even possible that a closet may be of sufficient size, so that the amount of air contained in it may hold the quantity of moisture imbibed by a given quantity of material.

If it were taken for granted that drying could be economically performed, without specific means of ventilation, it would be bad in principle; as the free passage of air through wearing apparel is of great importance in clearing them from impurities, humidity, soap, and other matters, and freshening them. It has been experienced at the Surrey Lunatic Asylum, that wearing apparel, dried in a closet without ventilation and at a low temperature, came out with a very unwholesome smell; the same description of things, dried in a closet with a higher temperature and free ventilation, came out relieved of all ob-

jectionable properties; and this may be considered a fact applicable to lazarettos, and other places for disinfection.

It must be unnecessary to dilate further upon the condition of hospitals, prisons, unions, lunatic asylums, etc., with hundreds, sometimes thousands, of inmates suffering under all sorts of maladies, whose linen and wearing apparel are mixed together in the process of washing and drying, without ventilation in the drying closet. A workman, when removing the closet at the lunatic asylum before mentioned, slightly grazed the back of his hand against a piece of wood in the upper part of the closet; the following morning his hand was much swollen, although the wound was scarcely to be perceived; for many days he was unable to work, and did not become entirely free from pain for two months, leaving no doubt but that his hand was affected by some poisonous matter on the surface of the wood, and that death might possibly have ensued. It is admitted that this is an extreme case, but it is also clear that extreme cases cause all the mischief; and considering that mankind is periodically visited with the most astounding and appalling maladies, without its being known from whence they come or how they are promulgated, in all sanitory arrangements too great caution cannot be taken to ensure safety.

In the construction of a drying closet separate and distinct from other apartments, care should be taken to have the ground on which it stands free from damp, and the floor well paved. The lining of closets is generally of wood, grooved and tongued to prevent warping; glazed earthenware tiles might be adopted with advantage; Tredgold recommended thin slabs of marble. The great point to be observed is, to avoid loss of heat from the external parts of the closets. All should be made fireproof where practicable: thus the external walls should be of cellular brickwork, the ceiling being arched; slate slabs are good materials where brickwork cannot be introduced. When constructed of wood, the planks should be placed diagonally, and of a double thickness reversed. If this cannot be done on account of cost, then the woodwork should be of tongued battens; all the framework being morticed and pinned. In closets having a cockel and pipe-heating apparatus, a floor should be formed of finely-perforated iron trellis work, or strong wirework of fine meshes, to prevent small articles falling upon the heated pipes, and endangering the clothes by fire; indeed, every possible precaution on this head should be taken.

The horses on which the clothes are hung, admit of some variety of construction. They are often made of wood. Iron is unquestionably better, from its durability and strength. The rods on which the clothes are placed should be cased with brass tubing, or they should be covered with zinc, to prevent the iron-rust staining the clothes. For large closets the horses should run on friction-rollers, or wheels, in grooved tramways, with guide rods for the upper part. There are various plans of making and fixing these wheels, they are generally what are termed "edge wheels", running in grooved or rebated rails; at the top of the closet the horses run in grooves, or wheels are sometimes added. The rails are in many cases single; they are also shewn so in the illustrations; the wheels being fixed one at each end of the horse, but in Fig. 1 the rails are double. In this example (from the Prestwich Lunatic Asylum) the horses are triangular, which thus affords more rod space, than even the arrangement shown in Fig. 18, Plate 2. The box posts at the front of the closet are rebated on the front and back faces, to receive the front and back doors, in which the rails are fixed. When pulled completely out to charge the horse, the door goes into the recess in the box posts; the same is done when the horse is put in its place, thereby preventing ingress of air. Instead of having edge wheels for the horses, Tredgold recommended rollers of considerable length, little shorter than the breadth of the horse door, the side plates of the rollers being fastened to the posts of the horses by bolts.

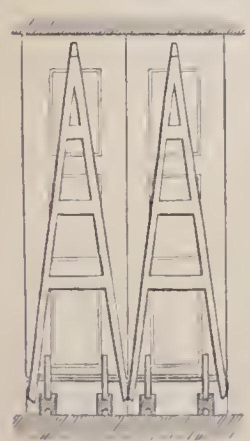


Fig. 1.

Fig. 2 is a plan of a drying closet, possessing some advantages, and it might be very cheaply constructed: A is a semicircular chamber with a properly-arranged heating apparatus underneath it; B, a centre pillar, with radiating rods *cc*, fixed all round it at proper distances, and of convenient heights. This column of rays should be equally divided by a nearly air-tight upright door, shewn at *dd*, which, when closed, leaves half of the number of rods inside, and the other half outside, the closet. As soon as one side is loaded, that is turned into the closet, and is drying during the time that the part then standing outside is being emptied and charged. In large establishments, two or more of these closets may be placed side by side. They certainly present considerable facility of construction and management, as they do away with the rolling in and out of large horses, and also the expensive construction attendant upon that plan.

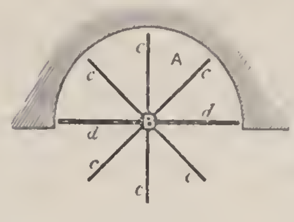


Fig. 2.

The construction of the furnaces must be left to the contrivance of the manufacturers, as different treatment will be required according to the nature of the fuel; the great point to be observed is the non-admission of superfluous air into the smoke flue, as all air admitted, over and above that required for the perfect combustion of the fuel, has a direct tendency to cool the pipes, and convey the heat to the chimney to waste.

The *method* of ventilating these closets is a subject of some difference of opinion amongst practical men, namely, as to whether it is best to take the ventilation from the bottom or from the top of the closet, and it would appear somewhat difficult to decide; it is certain that either way will answer the purpose. With the ventilating tube placed at the bottom, the heating apparatus being under the floor of the closet, and a sufficient admission of fresh air round it, the heat will rise through the clothes, taking up the moisture as it passes; then, becoming heavier, it falls down through the clothes, taking up a further quantity, and passes to the ventilator; the heated air circulating in the closet according to the laws of all fluids under the influence of heat. On the other hand, when the ventilation is from the top of the closet, the heat passes up through the clothes at once to the ventilating tube, and is lost. Again, when the ventilator is near the bottom, and the current in the ventilating tube very strong or rapid, much of the heat passes directly to the opening without effecting any drying, or passing amongst the clothes at all. Taking all things into consideration, ventilation is best from the top, provided the outlet have a properly constructed valve, capable of adjustment. Practically the best, or rather the quickest, plan of drying, is to shut up the ventilator until the closet has attained a considerable temperature, and then to open the ventilator, letting the vapour pass off as quickly as it will; for it is found by experience that when a charge of damp clothes is placed in the closet, the temperature falls considerably until the things have absorbed much heat (*i. e.*, the specific caloric required to change the water into vapour), and the drying is not rapid until they attain a considerable temperature. A thermometer should be placed in the external wall, sympathizing with the air of the closet.

Fresh air should be admitted in such a manner as to impinge on or sweep over the surface of heated pipe, the greatest quantity on the hottest part of it; it is doubtful whether the opening should ever be closed, although it has been recommended to have movable covers to admit more or less as may be required. Finely perforated gratings should cover these openings, to prevent the admission of small animals and insects, and to prevent combustible materials from being drawn in. All smoke flues should have air-tight covers to allow of cleaning out soot and dust.

The smoke flue of the heating apparatus should always be made the means of ventilation when practicable. The flue

should be double, that is, one flue outside another. The inner one, or smoke flue, should be constructed of stoneware pipes, ten or twelve inches diameter, with the apparent chimney built round it, Fig. 3, and the ventilation of the closet led into the casing. The advantage of this plan is that the gaseous products of combustion keep the flue pipe warm, creating a current in the surrounding case, so that there is a ventilating tendency from the closet. This might equally be effected by leading the ventilating tube at once into the smoke flue, but there is the liability of adverse winds, defective draught of the smoke flue, or other reasons which might cause the smoke to descend through the ventilating tube into the closet, to the serious damage of the clothes. The ventilating tube should have a valve, with a lever handle under the controul of the attendant, to stop or regulate the ventilator as may be required. It has been found that for a closet containing one thousand cubic feet, an opening into the ventilating tube of one hundred and twenty square inches, or about eleven inches square, has been ample. This may be varied according to the judgment; it is clear that a small opening, with a good current, will be efficient, when a large one, with little or no current, would be inoperative.

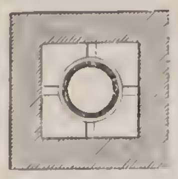


Fig. 3.

To assist in proportioning the requisite amount of heating surface in steam and hot water pipes, and by approximation, cockles and hot air pipes, TREDGOLD instituted experiments by which he was enabled to draw up the following list of the absorbent powers of different articles. In the trials, the clothes were wrung as they usually are in washing, before being weighed in the wet state.

	Weight dry.	Weight wet.	Weight of water absorbed.
Wool, in flannel . .	1 lb.	3 lbs.	2 lbs.
Cotton, in calico . .	1	2·125	1·125
Silk	1	1·9666	0·9666
Flax, in linen . .	1	1·75	0·75
Flax, in sail cloth .	1	1·75	0·75
Paper, foolscap . .	1	1·2857	0·2857
Paper, drawing . .	1	1·24	0·24

" Now, in order that equal weights of these different species of goods should be dried in equal times, the force of heat for the flannel should be sufficient to abstract 2 lbs. of vapour; while that for the calico need only be sufficient to abstract 1 lb.; and that for the linen three-quarters of a pound."—TREDGOLD, *Treatise on Warming and Ventilation*, page 251.

By adopting 90° as the maximum temperature of the heat used in a drying closet, he also formed the following rules for proportioning the quantity of pipe and ventilating orifices. At a temperature of 90°, the mean of several experiments shewed that one cubic foot of water was evaporated from each 2700 square yards of cloth, or 5400 square yards of surface, each piece of cloth having two sides or surfaces, or nearly one-hundredth of a cubic foot for each piece of cloth of twenty-five yards. For each yard he found that fifteen cubic feet of air per minute were required to carry off the vapour; this he however doubled, making it thirty, so that for a piece of twenty-five yards, 750 cubic feet of air per minute were required to carry off the vapour—" the heat required per minute for each piece of twenty-five yards, will be equivalent to evaporating one-hundredth part of a cubic foot of water, and heating 750 cubic feet of air from the temperature of the external air to 90°. The quantity of steam pipe to evaporate one-hundredth of a cubic foot of water is 138 superficial feet. The quantity to heat 750 cubic feet of air to 90°, supposing the external air to be 40°, is, (by the rule given in HEAT) equal to 132 feet"; adding these quantities together, the area of pipe for each twenty-five yards of cloth is 270 feet. The area of ventilating tube is easily found; for each 270 feet of surface of pipe 750 cubic feet of air is to be passed through each minute; to this latter quantity is to be added one-thirtieth of its bulk of steam, making 775 cubic feet. Using the formula of TREDGOLD (*Treatise*, art. 64, note), $\frac{B}{300}$ cubic feet $\times \sqrt{\frac{450+t}{h(t-x)}}=a$ or area; where t=internal temperature, say 90°; x=external temperature, say 40° (less 6° for inferior specific gravity), and h=height of ventilating tube, say 25 feet, to be measured from the centre of the hot chamber to the top of the egress aperture, the quantity a will be about 1·5 square feet for each 270 feet of surface of pipe. In making calculations for drying closets, it is not enough to estimate the mere cubical contents of the apartment,—though this is necessary in calculating the area of heating surfaces,—the lineal dimensions of the drying rail ought also to be taken into account; as by a judicious arrangement of the horses, additional feet in many cases may be obtained; the lineal dimensions being given, the average quantity of cloth which may be hung thereon may be estimated; this being known, approximative estimates of the heating surfaces may be easily obtained. If the temperature is wished higher than 90°, all that is requisite is to alter the multiplier in finding the area of pipe.

One superficial foot of iron water pipe, constantly maintained at 150°, will warm 100 cubic feet of space about 20° in ordinary dwelling houses, without especial means of ventilation; and one superficial foot of steam pipe at 212°, will warm 200 cubic feet the same number of degrees, presuming the air to be at 30° previously; and probably one foot of steam pipe at 250°, would warm 300 cubic feet the same number of degrees. One foot of small pipe will produce the same effect on 400 feet, when the pipe is maintained at 350°. One superficial foot of stove or pipe surface heated to 600° will produce the same effect on 600 cubic feet of air. It will be readily seen that these data are only approximative, but they will be found of service, as it is merely required to calculate the cubic space to be heated, and multiply the quantity of radiating surface; for instance, a closet to contain 1000 cubic feet, or ten feet each way, then

100 sup. ft.	of water-pipe	at 150°	will produce	100°	in the closet
50	,,	steam pipe	212	,,	100	,,
100	,,	ditto	212	,,	120	,,
50	,,	ditto	250	,,	135	,,
200	,,	small pipe	350	,,	200	,,
100	,,	cockle	500	,,	230	,,

The above data are as near as the nature of the subject will admit; the quantities should on no account be less than those named, but rather more, as the amount of ventilation, and the degree of conducting power of the surrounding material varies so much in every case that it is next to impossible to construct exact tables; the difficulty may be estimated when it is considered that high temperatures cause rapid dispersion of heat. The above data have been repeatedly proved in a very extensive practice, and may be relied on; but much depends on the judgment, and considerable allowances must be made for variation in the material of which the closets are constructed, or of the containing walls; the radiation, conduction, and ventilation increase so rapidly with every rise in temperature, that the additional warmth is gained in an uncertain progression: and when very great heat is required, much increased power of apparatus will be necessary.

When drying began to be practised as an accessory to our manufactories, the arrangements were incomplete and unsatisfactory. A very usual form was a room provided with a common stove, the materials to be dried being hung from lines or spars, stretched across, near the ceiling. The " cockle" was also used, the major portion of it being in the room, the materials to be dried being protected from the overheated surface by wirework. Fig. 4 is a section, and Fig. 5 a plan of a cockle; *a a* is the iron casing; the flames and smoke arising from the furnace *f*, pass up and over the partition *b*, and down by *d*, out to the flue by the piping *c*; *e e* shew the line of wire work. The heating surface may vary from 200° to 1000°, or just red hot. It is by no means advisable to heat iron much above 400° for these purposes, as, at a greater heat, iron-work deteriorates fast from oxidation; and sulphureous gases and unequal expansion

soon cause the vessels to warp, crack, and become dangerous; it is obvious, therefore, that all apparatus on this plan requires to be carefully guarded from combustible materials.

Fig. 4. Section.

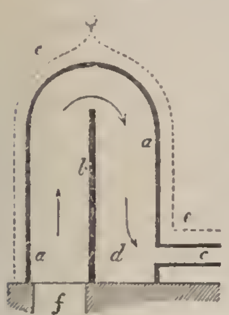


Fig. 5. Plan.

For dwelling houses in towns, where open air drying cannot be obtained, a closet with its heating apparatus may be made of great efficiency in a small space, the stove for heating the flat irons being the means of drying the clothes. There are several modes of accomplishing this object. Figs. 6 and 7, Plate 2, being plan and elevation, illustrate an arrangement of this kind, the smoke flue (shewn in Fig. 7), passing in a zigzag manner at the back of the closet. A diaphragm of wirework should separate the horses from the pipes, and the back and sides of the closet should be of non-combustible material.

Fig. 8 is a useful and safe plan for a large family when there is available space. A The washing room, B drying room, C ironing room, *d* stove for heating the flat irons, put under a fireplace for ventilating the ironing room; the smoke flue going out at the back, and branching into four iron pipes, *e e e e*, each five or six inches in diameter, and entering into the smoke flue, *f*; this is found both efficient and economical. It is necessary to enclose the pipes, as before observed, for safety; and to provide flue doors at *g* for clearing out the soot. The materials to be dried hang on racks or lines, or in any other way most convenient.

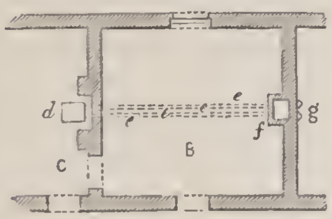


Fig. 8.

The grand improvement in drying closets was introduced by Mr. Strutt of Derby. Instead of having the materials dried by hanging them in the heated atmosphere of the closet, whence they were to be removed by hand, he used arrangements by which the linen, etc., could be put on a rack in an apartment distinct from the drying closet; this rack, when filled, being capable of motion on wheels working into rails laid on the floor of the drying closet and contiguous apartment. The closets being heated by an arrangement of stove or cockle.

In the following figures on Plate 1, there are sketches of an improved construction of closet, having movable horses; the heating power being derived from cylindrical pipes, connected with a cockle or furnace. Fig. 9 is an elevation, Fig. 10 a plan, and Fig. 11 a transverse section. The tube for leading the products of evaporation to the chimney is provided with one or more valves to regulate the degree of opening; the box posts forming the front of the closet are rebated, as before described.

The following is a statement of the cost of working a closet formed on this plan, having seven horses fitted in it:

Fuel consumed including lighting.	Cost of fuel.	Lighted at 9.	Thermometer.
Wood	$\frac{1}{2}d.$	half-past 9	68°
Coals 14 lbs.	$1\frac{1}{2}$	half-past 10	132
Coke 1 cwt. at 21*s.* per bushel	1*s.* 3*d.*	half-past 11	182
		half-past 12	208

"It therefore cost 1*s.* 5*d.* to produce 208 degrees, which heat is more than required even for the coarsest sheets. The above heat was produced so gradually, as not to make the exterior iron-work red hot, nor even the internal neck of the stove, which it has generally been, when worked by the laundry women. Ninety-eight sheets were put on the horses all at once, and the laundry women have dried sheets in ten minutes, which should not be allowed, as drying is sufficient quick for them to be able to clear the first horse by the time the seventh is filled and closed, which the closet will do."—Builder, vol. vii, p. 338. Mr. Cooper, the originator of this species of drying closet, further says, in reference to the plan often adopted, of having the heating power supplied by the tube or smoke flue of the ironing stove passing through the closet,—"Reference to the explanatory sketches will show we prefer and use a furnace or fireplace distinct from the ironing stove, the whole of which fireplace is lined with six-inch thick Welsh lumps, and the connection of such fireplace with the heated flues is at a depth from the top of it; this arrangement allows coke always to be used: the charge being filled full, prevents any cold air from passing over the fire, as in the usual way into the flues, to the evident waste of the fuel, and it induces a total absence of smoke, creating only a fine drift or powder within them, easily removable. I have been compelled to give a preference to a fireplace, for the use alone of the drying closet, as in two distinct instances I have proved that when the quantity of clothes to be dried has been large, and the closet in constant use all day, and say, in five out of six days, the ironing stove, to be fully effective to the closet, has been obliged to be worked at far too great a heat for its own duration, besides overheating the room in which it is placed and where it is generally exposed. It has consequently been destroyed infinitely sooner than it would if confined to its own use."

In very small closets, the stove is best placed under the horses, the pipe or smoke tube passing also beneath them; the door for supplying the fuel being at such a position that the access thereto can be easily gained. Fig. 12 shews this arrangement; *e e* is the floor of the drying closet, on which the horse rails are laid; *f f* that of the foundation; *a* is the stove made of iron; *b* the smoke or heated air flue; *c* a hopper passing through the front wall, and communicating with the interior of the stove; it is provided with a lid or cover, which is taken off when fuel is to be supplied; *d* a small door by which the ashes are withdrawn from the ash-pit. Mr. Cooper dispenses with the large air drain, but provides a sufficient degree of ventilation by making an opening or slot extending the whole length of the front of the closet, the breadth being from half to five-eighths of an inch; this affords ample air to maintain ventilation, and by joining the ventilating tube into the furnace flue, the strong rarefaction within it produced by the heat, creates a power sufficing perfectly to ventilate the closet, the valve in general being open but one-half its range.

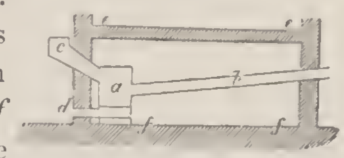


Fig. 12

Drying closets for prisons, unions, asylums, etc., require much more powerful treatment; they are seldom less than ten feet square, often double this size. It is usual to place the heating apparatus under the closet, and it is necessary to maintain a high temperature on account of the great quantity of clothes to be dried. It is found that 100° of heat is quite inefficient for these establishments; the material would be injured at a heat much exceeding 200°, which of itself would be dangerous, and it may safely be stated that 160° or 180° would be found quite sufficient.

The Figs. 9, 10, and 11, before referred to, shew a large closet adapted for five hundred inmates, twenty feet long, ten feet wide, and eight feet high. It has twelve horses, the front faces of which, as well as the horses themselves, may be made of iron, but the enclosing sides of brickwork and slate; the whole of the bottom should be covered with perforated zinc, etc., as before described.

It will be obvious that there will be a great difficulty in raising the temperature to 100°, for drying purposes, in a closet heated on the low-pressure plan, with hot-water pipes averaging 150°: in fact, if the whole closet were filled with pipes at that temperature, it would be difficult to exceed the first-named heat by many degrees, and with free ventilation the difficulty would be insuperable: of course, if the pipes were placed in a case completely air-tight, and the containing case or closet were surrounded with perfectly non-conducting substances, so as effectually to prevent radiation or ventilation, the air of such closet would go on accumulating heat, till it attained the average temperature of the pipes, but in such a closet little drying could be effected. A closet or small room may, however, be heated

moderately with this kind of apparatus; and, allowing plenty of time and space for the air to circulate about the linen, it would be found to answer well for many purposes, and is also unquestionably safe, which is its greatest recommendation.

The applicability of the small pipe, or Perkins's heating system, has hardly been sufficiently appreciated. By this apparatus a temperature of 350° can easily be maintained in the pipes themselves; therefore, by placing the requisite quantity of material at this temperature, any required heat can be maintained under 230°, which has been often proved in many working closets; indeed, this plan affords greater facilities for drying purposes than any other. It may be observed, that it requires considerable skill and knowledge to erect it successfully. The next question is the safety of this form of apparatus, seeing that water at 350° has the explosive force of steam at the same temperature, namely, 135lbs. on the square inch. This at first sight presents a very dangerous aspect; but when it is known that the pipes of which the apparatus is constructed will bear a pressure of 4000lbs. on the inch, and are always proved to 2000, the difference is so great, that all fears on that head may be safely said to be at rest. The coil in the furnace should never exceed one-eighth, or better one-tenth, part of the whole series of pipe, providing they are of uniform area; and it has been experienced that no degree of heat, which can, under ordinary circumstances, be applied to the fire part of such an apparatus, can produce any dangerous effects, provided the water be unimpeded in its circulation, and this is a matter of easy attainment; the expansion tube should have a capacity of one-tenth of the whole contents of the pipe, inclusive of the furnace coil: the pipe must be guarded from wood or the materials drying, which it would inevitably scorch.

Upon this principle, and on a plan as safe but more expensive than that shewn by Figs. 6 and 7, is the arrangement illustrated by Fig. 13, Plate 1. The ironing-stove or furnace is made with a properly-constructed boiler, from whence the pipes pass through the closet between the horses; another portion of the pipes being made to heat a tank of water for the supply of the washing tubs, which may be in an adjoining room, so as to avoid all the disagreeables of steam and damp. This arrangement appears, after being many years in use, to be one of the most complete, and, taken altogether, of a very economical construction.

Similar arrangements, in establishments where drying closets worked by hot water which also supplies the wash-tubs, are employed in conjunction with laundries, will be found exemplified in Fig. 14, which represents a longitudinal section of a drying-room placed above a wash-house; *h* is the flow pipe, and *i* the return pipe supplying hot water to, and withdrawing it when cooled from, the congeries of pipes *k*. The cold air gains admission through the grating, as shewn by the arrows, passes in contact with the pipes *k*, is heated thereby, rises up in the box *l l*, through the grated openings *m*, past the horses, out by the ventilator *f*, which is provided with a valve as before described. The bottom of the cold-water supply cistern must not be lower than the top of the cistern connected with the boiler, which is supplied therefrom by the pipe *n*, at the same time carrying cold water to the washing tubs; the boiler supplies hot water for the wash-tubs by the pipe *o*. Fig. 15 is a plan of the ground floor, and Fig. 16 that of the upper floor; the references apply equally to the three illustrations.

Steam pipe offers greater advantages than those of the low-pressure hot water principle, with regard to the temperature; as steam, conducted from a boiler working at about four pounds on the inch, would fill the pipes so as to produce an uniform temperature of 212° in them; and, although a higher temperature can be maintained, in the proportion of 150 to 212, yet the same reasoning applies as with the hot water apparatus.

The next means of producing heat is by means of high-pressure steam, where, by using a boiler working to thirty or forty pounds on the inch, a temperature of 250° may be obtained; but the fact of the explosive nature of steam at such high temperatures, prevents the use of such an agent for domestic purposes, independently of the necessity for employing a skilful mechanic (causing a further expense) to superintend the use of such an apparatus; indeed, steam boilers of more than four pounds pressure on the inch, should not be used for any domestic purpose.

The following sketch, given by Tredgold, will illustrate the arrangements of steam pipe usually employed soon after steam began to be employed for heating purposes. Fig. 17, Plate 2, is a longitudinal section, and Fig. 18 a transverse section: three of the pipes traverse the whole length of the closet, and three are placed between the two horses. The fresh air is admitted near the bottom, passes over and between the pipes, through the horses, and escapes with the vapour by the ventilating tube, which should be provided with a valve, as before described. The steam pipes between the horses lessen in diameter as they approach the top, the heat not being required there of such a raised temperature. A division, *g g*, is placed extending within a few inches of the roof; slits or apertures are left at each side, along the whole length of the closet; these slits are narrowest in the middle, where the influence of the ventilation is strongest; and broader towards the ends, where it is weakest: the steam and heated air pass through these, along the upper side of the division, and out at the ventilator. To allow of expansion, the pipes should be placed on rollers, as shewn in the drawing, and in the article Heat. "The great advantage of this form of drying closet consists in confining the heat entirely to the substances to be dried, and consequently saving fuel; in keeping the laundry free from damp air and oppressive heat; and in rendering less space necessary. In this method of drying, the persons who are engaged in managing the process are not at all incommoded by the heat, nor by the steam from the wet cloth. For domestic purposes, there will be quite as little expense in fitting up an apparatus of this kind, as the commonest in use. One of the boilers in the wash-house will answer as a steam boiler, without rendering it the less fit for other purposes; those heavy and dangerous frames, usually employed to hang the clothes upon, will not be at all wanted; nor nearly so large a room for the laundry. And it is not an inconsiderable recommendation to this plan, that an immense quantity of fresh air will have to pass through among the linen while it is drying, which must render it more pure and fit for use."—Tredgold, *Warming and Ventilating*, pp. 259, 309.

Steam as a drying power has been largely used in this country, and in many cases on an extensive scale. The following figures are reduced from the working drawings of a drying closet fitted up at the Lancaster County Lunatic Asylum, which dries the linen, bedding, etc., of from seven hundred to eight hundred persons. Mr. Walker, of Manchester, was the designer of it. Fig. 19, Plate 2, is the ground-plan, shewing arrangements of pipes, which were originally fitted up as indicated by the dotted lines, and found to be very deficient in heating powers. The range marked *g g* was added. Fig. 20 is a plan shewing the position of the pipes placed between the horses, and Fig. 21 is a transverse section, of the manner of arranging these pipes in inclined pairs. The scale is one-twelfth of an inch to the foot. The cubic contents of this closet are 5,040 feet: constant ventilation of 288 square inches, or two square feet, is provided; with means of increasing it in moist close weather. The textures dried are unusually thick and heavy, and not easily wrung by female hands; and hold on the average twice their own weight of water when placed in the closet, thus: weight of a dry rug, $4\frac{1}{2}$ lbs., wet 13 lbs.; weight of wet clothing dried daily in twelve hours, 4,006 lbs.; water evaporated in same time, 252 gallons; temperature 120° when the clothes are put in, increasing to 170° when dry.

It is almost unnecessary again to repeat, that in many drying closets, evaporation has been found to be greatly accelerated by increasing the rapidity of the heating current,

thus producing an effect equivalent to the action of a high wind, in drying in the open air. This acceleration has been effected by the use of fanners, screws, pumps, etc., worked by a steam engine or other power. The new process of drying (introduced by the Desiccating Company) by Messrs. Davison's hot-air patent, is on this principle, and is perhaps the most effectual method yet introduced. The process can be regulated with the utmost nicety, and is applicable with equal ease to a drying closet, the cubical contents of which is 30,000 cubic feet, as to one of 300; but it requires machinery to keep it in motion. It is the same as that described in the article HEAT, at p. 10, as a series of tubes formed into a cockle of a semicircular or horseshoe form, placed over a fire, with a fan attached to the lower part of it propelling air constantly through the series of pipes forming the cockle, sweeping the heat from the internal parts of the cockle into the drying chamber. The use of the fan is to compel a current of air to pass into the chamber, independently of the natural system of ventilation caused by the difference of specific gravity of heated columns of air, which would appear to be unnecessary, seeing that by a properly-constructed air-flue, a ventilating current can always be provided. The system can be applied to some manufactories where the drying chamber is by no means air tight, so that without the force of the fan or other power being applied, the heated air would not find its way to all the corners of the chamber, but escape at the nearest openings. As the fan cannot be worked without a steam engine, or some other equivalent moving power, this fact would appear to limit its usefulness: it might also be apprehended that a fire sufficient to give the required heat, when the fan was blowing air through the pipes, would be liable to destroy them when the operation of the fan was suspended; but no doubt this contingency is provided for: and there is no question but that this system will be found a most efficient means of desiccation for many purposes.

The most striking advantage obtainable by the use of this process for the purposes of drying linen, either in private houses or public establishments, is, the immense quantity of fresh air which is forced through and among the articles to be dried. For linen in hospitals, etc., where it is likely to be infected, we conceive the process to be invaluable. On this point, DR. COPLAND, in his *Medical Dictionary*, vol. ii. p. 245, thus writes: "In all cases where the clothes, linen, and bedding are infected, or even suspected, disinfecting agents should be applied to them. Of all disinfectants, high ranges of temperature are the most efficacious; and the best method of employing a high temperature, with the view of decomposing the morbid effluvium retained by the bedding or clothes of persons who have laboured under pestilential and infectious maladies, is that invented by Messrs. Davison and Symington, who recommend the transmission of air through a chamber in which those articles are suspended; the temperature of the air being raised to grades varying from 200° to 250° of Fahrenheit. The advantage of this method is, its easy applicability to all kinds and to any number of objects and articles, without injury to their textures or fabrics." As a proof of the beneficial effects of currents of highly heated air in disinfecting clothes, the case may be cited which was tried in Syria; the clothes of sixty persons, who had died of the plague, were subjected to currents of air at a temperature of 240° Fahrenheit; these clothes, thus purified, were worn by sixty persons, not one of whom caught the infection.

Fig. 22 is a section of a drying closet for calico printing; the heated air is sent from the furnace by the power of the fan through the pipe *g g*, gaining access to the room by the apertures as shown. In drying closets for yarns, the saving of fuel is most important. In a chamber, the cubical capacity of which was twenty-two thousand feet, five thousand pounds of bleached linen yarn were hung; the moisture of which was nearly of equal weight (four thousand two hundred pounds of pure water). The apparatus completely dried the above quantity in nine hours, the average temperature being 110°, the quantity evaporated being at the rate of four hundred and sixty-six pounds per hour. The quantity of fuel (Scotch) consumed per hour under the apparatus, is one hundred and twenty-eight pounds, being one pound of coal for every 3·64, or upwards of three and a half pounds of water evaporated. The small engine which worked the fan, consumes about sixty-four pounds of fuel per hour, which, added to the former, shows that 2·42, or say, two and a half pounds of moisture, is expelled for every pound weight of fuel used.

The process is also easily applicable to large drying closets as generally constructed, with movable horses. A modification of the arrangement shewn in Fig. 23 would be very efficient; *g* would form the hollow space beneath the rails *b b*, the horses occupying the chamber *h* above them; the ventilator to be opened and shut by means of a chain. The illustration shews the application of the process to the drying of grain or seed; the floor being formed of perforated tiles, or plates of cast iron. The next diagram, Fig. 24, is a representation of a fire-proof building to be used in connection with the above plan, for the drying or desiccating of timber: *g* are the brackets or supports on which the timber to be dried is placed; the hot air passing up through between them on its way to the ventilator *f*. The walls are made hollow to retain the heat.

The power of drying quickly and conveniently, is found to be of the utmost importance in public laundries, in order to save the time of the washerwoman: to enable her to dry one portion while her time is occupied in washing another, she should have a drying closet to herself close at hand. By such an arrangement, her feelings of self-respect are not violated by the necessity of exposing her humble attire to the view of others in one large closet, to which all persons using the laundry would be compelled to have recourse. Mr. Baly, at the St. Martin's Baths and Laundries, at Hull, Bristol, and other establishments erected under his direction, has managed this very happily. At the first mentioned place, the woman has simply to draw down a clothes rack, having weights sufficient to counterpoise it and the clothes; the which clothes, after hanging in the closet a few minutes, are found to be sufficiently dry. The heating pipes are arranged according to Fig. 25.

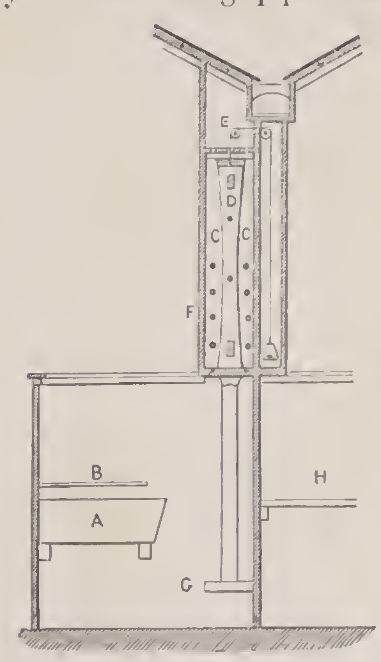


Fig. 25.

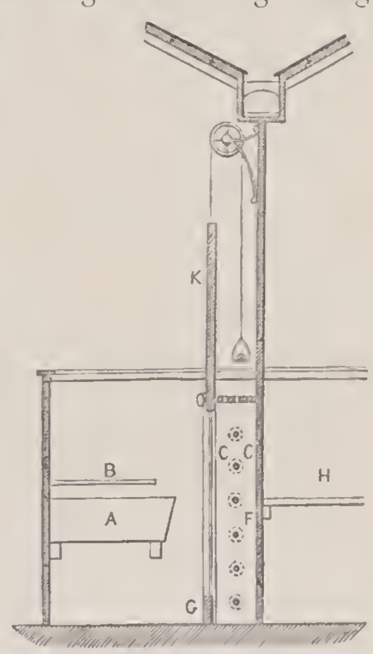


Fig. 26.

A, the washing tubs; B, the dripping board; C, the closet; D, the horse; E, ventilator; F, the pipes; G, the stop to receive the horse; and H may be either another washing place, or the ironing board, etc.

At the Hull and at the Bristol laundries, the closets are by the side of the washing tubs, instead of being above. In Fig. 26, the clothes are thrown over the pipes, so that the whole action of the heat is exerted within the drying material; a kind of saddle of wirework or open zinc is placed over the pipes to protect the clothes from contact with them, and the things are found to dry in a surprisingly short space of time. The letters of reference are the same as those of Fig. 25, and K is the door

which lifts up and down, having a balance-weight attached. To one range of seven sets of wash-tubs, there are as many sets of drying closets, each separate and distinct.

This plan is peculiar to Mr. Baly, and reflects much credit on his powers of arrangement. In the closets, a heat of 200° may be constantly maintained; great difficulty was found in providing an efficient and uniform mode of heating them. Steam pipes were first applied, with very considerable pressure of steam, probably twelve pounds on the inch; they were found to be quite ineffectual, precisely from the reason before assigned; as it is impossible to obtain a temperature of 200° from steam pipes a little above 212°, and that with ventilation. A stove with heated flue-pipes was also tried, which also failed, from the fact that heat evolves or is radiated from hot bodies as the square of the distance, and is only diverted from this by currents. In these experiments the first closet was overheated, the second tolerably well, and the third very imperfectly; but upon the application of the small pipe principle, the heating was found particularly efficient and uniform. The apparatus employed is that described Fig. 13, Plate 1.

If the reader will refer to the description of the several means of producing heat set forth in this article, it will be clear to him that any required temperature for desiccating purposes between 80° or less, and 1000°, may be accomplished, by using the one best adapted for his purpose. Of the various kinds described, that of the hot-water apparatus may be applied to the drying of gunpowder, or almost any other inflammable material; as the boiler and fireplace, at which the heat is generated, may be placed a mile away from the drying room, if such a precaution were considered desirable; and the heating pipes could be completely insulated from the boiler by means of the intervention of cisterns, and the connecting-pipes coated outside with nonconducting substances. By means of a thermometer sympathising with the heated water in the pipes, any precise temperature may be ensured within the limits of the heat of this description of heating apparatus. The dreadful and unaccountable explosions which occur at powder-mills, suggest that every available means of precaution should be taken with this branch of manufacture.

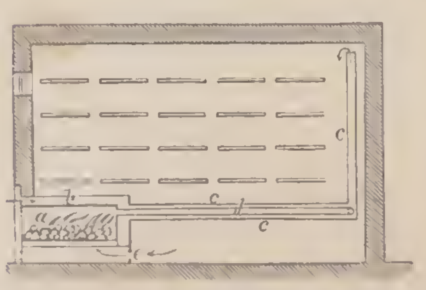
The drying apparatus used for manufacturing purposes are so numerous, that it would be an endless task to suggest or to describe them further than has been done. From those which have been described, manufacturers would find no difficulty in selecting the plan best adapted for the especial purpose, or finding competent mechanics to construct a suitable apparatus. It is the besetting error of inventors, like vendors of some universal panacea, to fill the minds of the public with their nostrums, making them believe their peculiar apparatus is everything for all purposes; whilst the regular practitioner, with sound judgment, selects the proper material for the required purpose.

William Healy.

In drying closets for chemical and pharmaceutical purposes, there are some requisites which may in other processes be overlooked. The substances to be dried are various, as herbs, etc., which by a high temperature would be liable to injury, and yet would spoil if not perfectly dry. Extracts also require the greatest care to prevent injury from over-heating. Other substances again, as salts, from which it is required to drive off the water of crystallization, demand a high degree of heat. It should therefore be in the power of the operator to maintain a temperature of 100°, or even less, and to increase it at pleasure to as much as 250°; but whatever is the degree required, it should be preserved without much variation.

Figs. 27 and 28 shew the section and plan of a closet adopted by Mr. Redwood, Professor of Practical Pharmacy to the Pharmaceutical Society, and which has been found to answer well. The closet is of brickwork, with a closely fitting iron door. Where it adjoins an outer wall, or one liable to damp, it should be lined with zinc, leaving a space of half an inch between it and the wall. Light is admitted by apertures closed with fixed plates of thick glass. The furnace, *a*, is of iron, enclosed in an air chamber, *b*, communicating with a square pipe *c*, the length of the closet, and terminating in an upright pipe reaching to within two inches of the ceiling. The smoke flue, *d*, passes through the horizontal portion of this pipe, and enters into the chimney. The ash-pit door, as well as that of the furnace, are closely fitted and kept shut; the fire being supplied with air *entirely* from the closet, the quantity in which is kept up by the admission of it through the before-mentioned air pipe and chamber, which last communicates with the external air—by this means ventilation is constantly carried on; the heated air diffusing itself through the trays as it is drawn down into the opening *e* of the ash-pit. The degree of heat is regulated by a damper in the flue, and the ventilation by a similar damper in the upright pipe.

Fig. 27. Section.



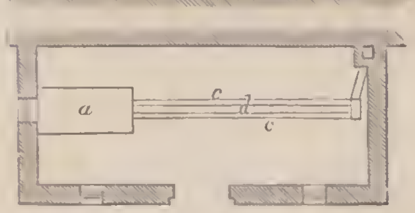


Fig. 28. Plan.

A closet on a smaller scale, according to the size of the trays required, is shewn in Fig. 29. It may be of wood lined with zinc, having a cavity of half an inch between it and the wood casing. The shelves for trays are to be placed alternately, the door fitting close to their front edges, so that the heated air must pass over the whole of them in its passage from the entrance *a* to the exit *b*. The ventilation is provided for by a double flue, as shewn in Fig. 3, and the air heated by a chamber attached to the furnace used for the general purposes of the establishment.

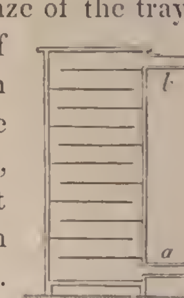


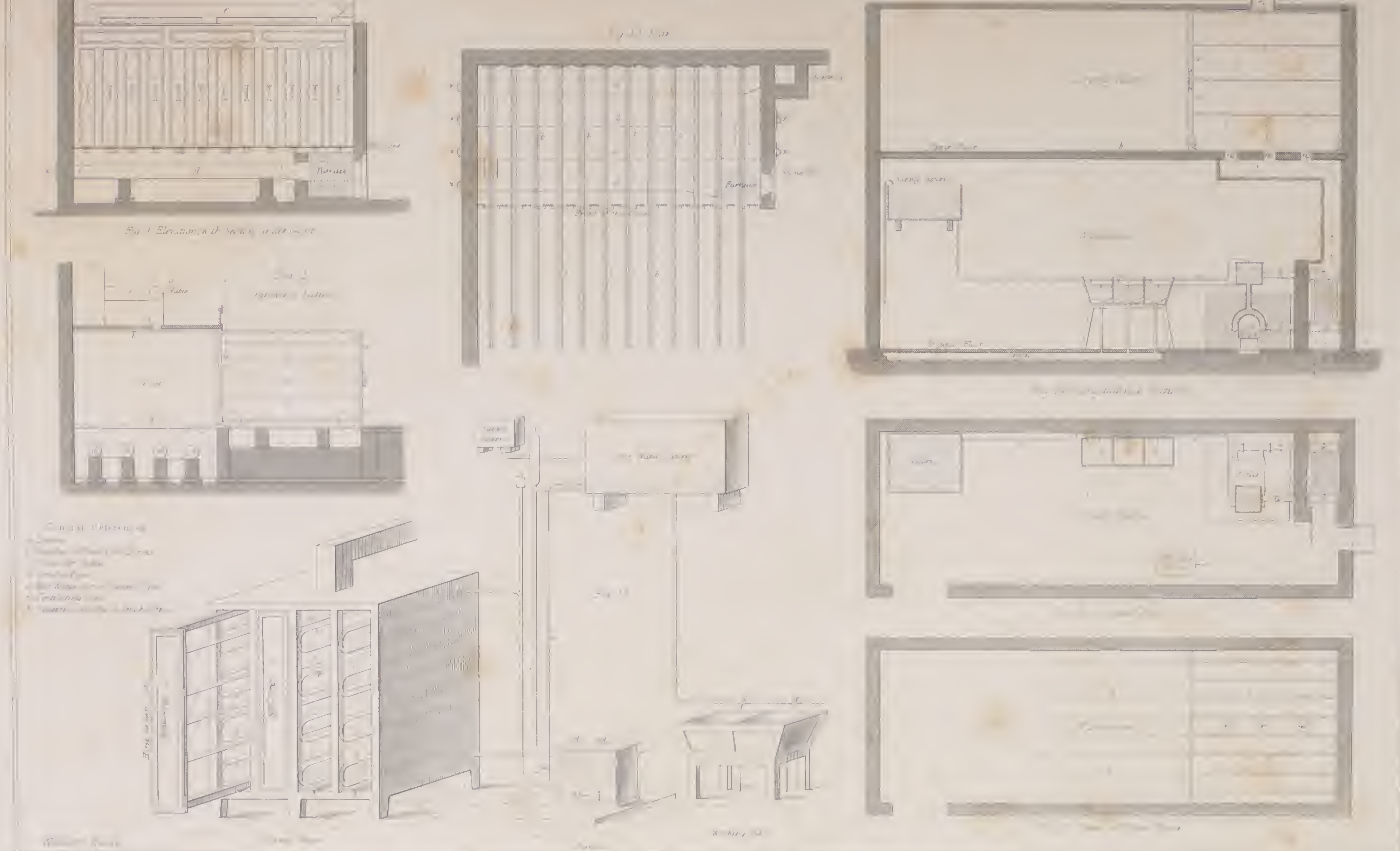
Fig. 29. Section.

It would seem preferable, however, in all cases, to make use of hot water, from the greater facility for accurately regulating the temperature, and the small pipes on the high-pressure principle must of course be adopted, on account of the high degree of heat sometimes required.

J. B.

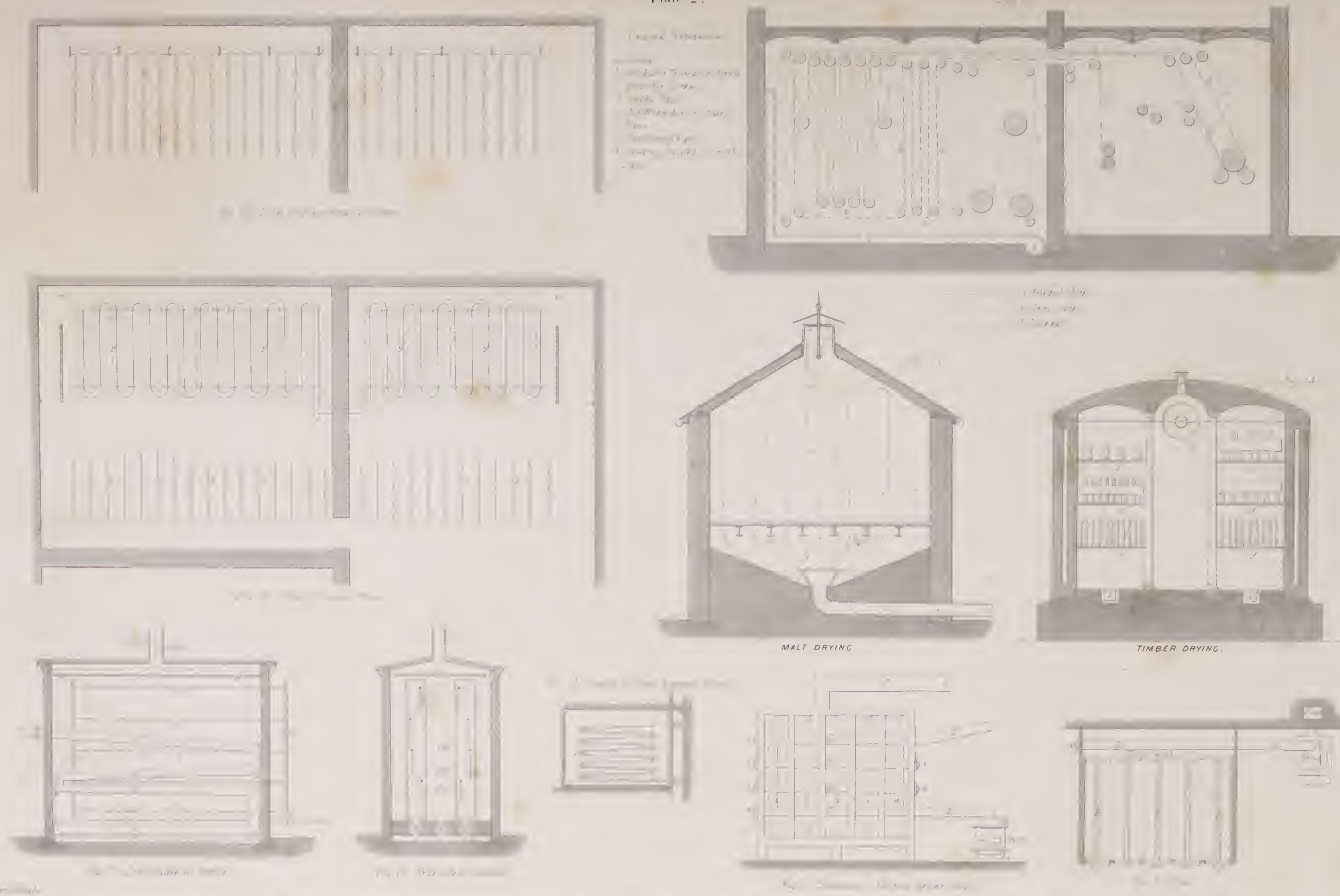
DRYING CLOSET.

Plate 1.



DRYING CLOSET.

Plate 2.



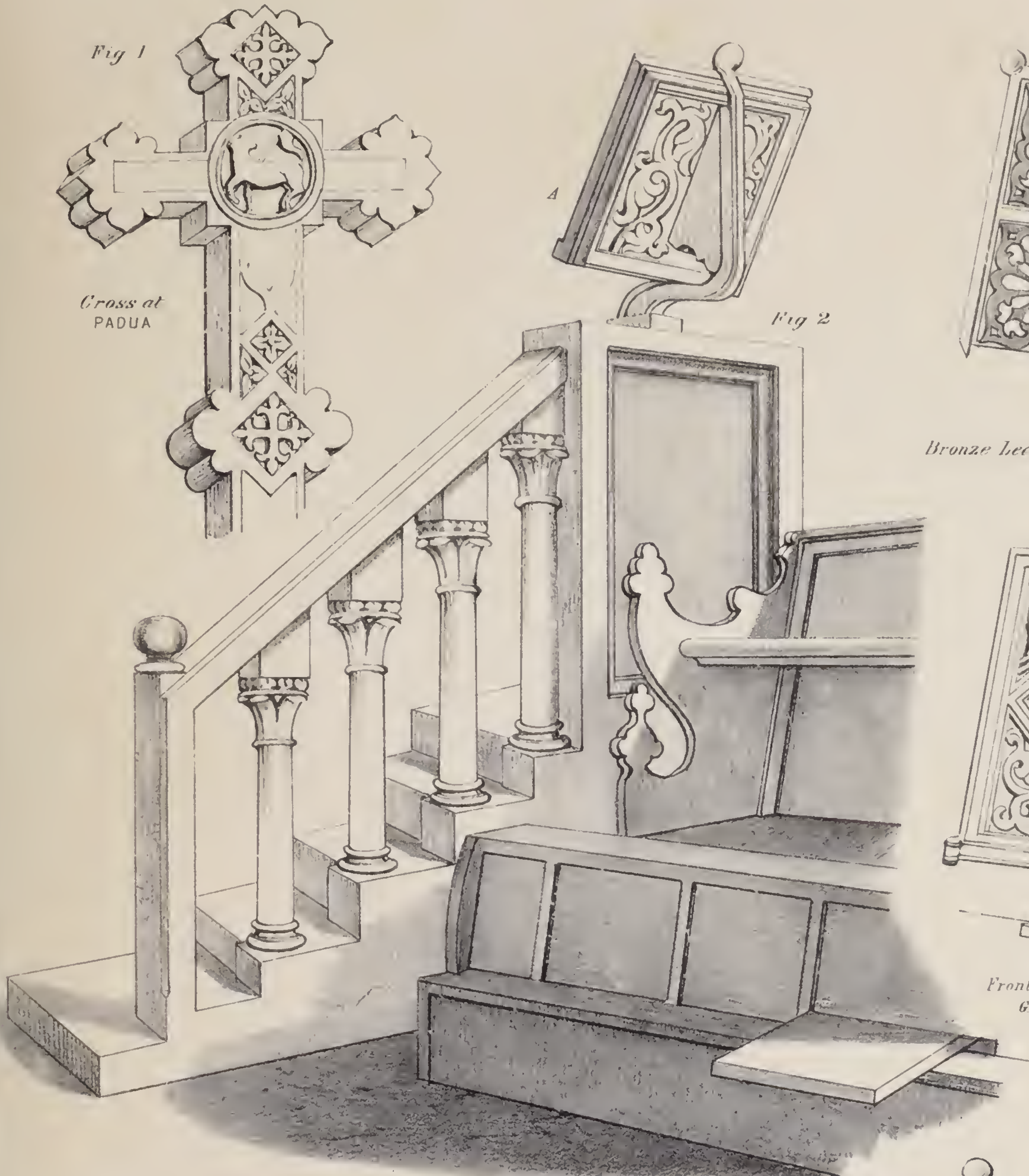
PULPIT

Fig 1

Cross at PADUA

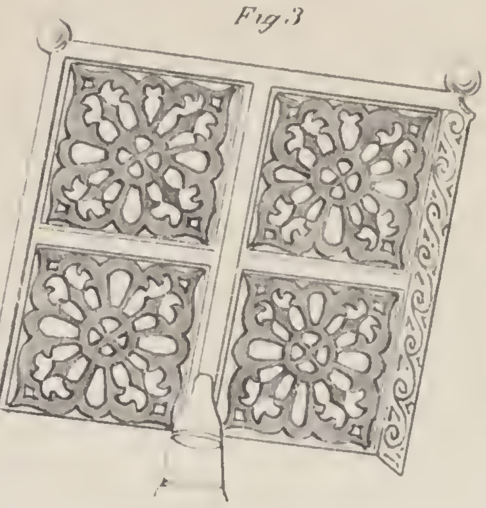
A

Fig 2



Ambo in GIOTTO'S CHAPEL PADUA

Fig 3

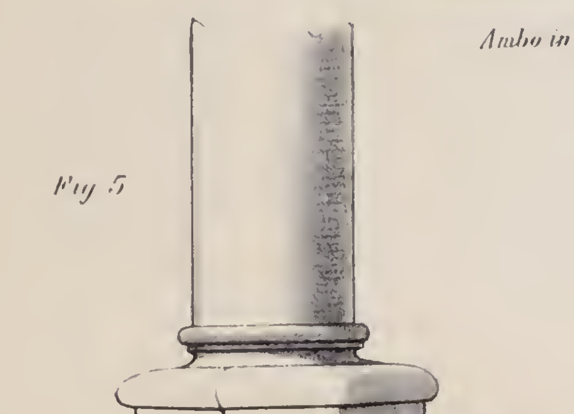


Bronze Lecturn in GIOTTO'S CHAPEL PADUA

Fig 4

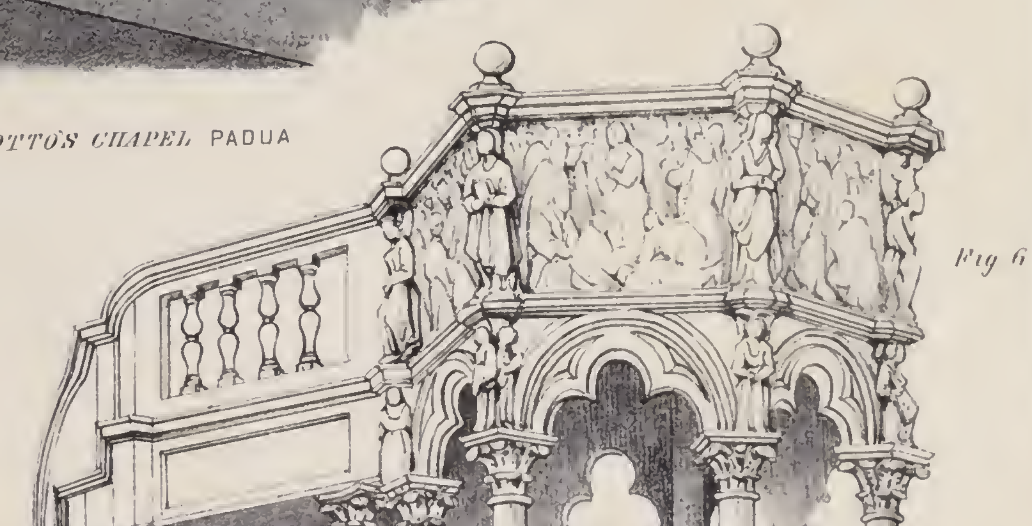
Front of the marble desk at A Fig 2
GIOTTO'S CHAPEL _ PADUA

Fig 5



Base of central column of Pulpit SIENNA

Fig 6

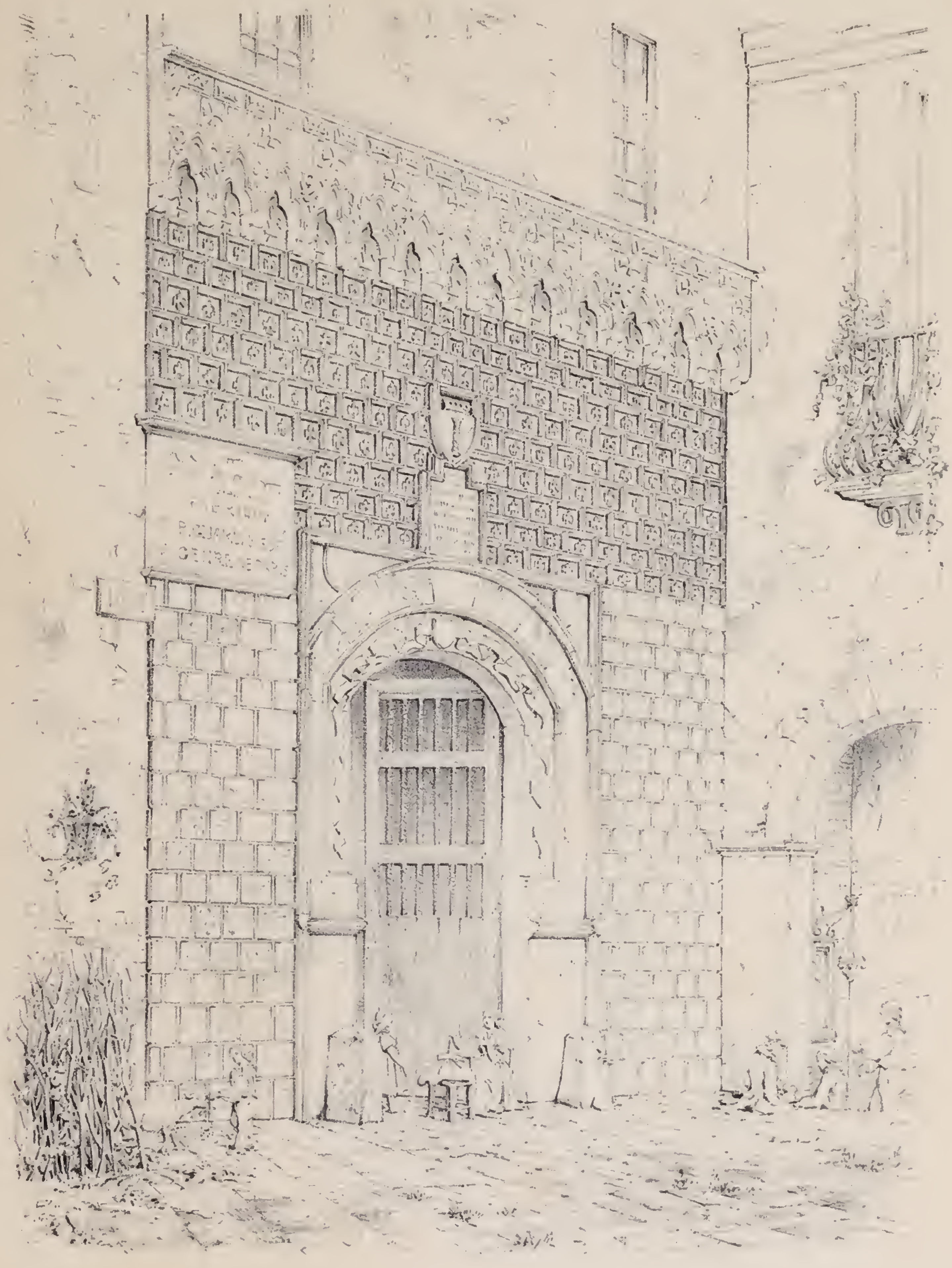


Pulpit in CATHEDRAL _ SIENNA

Benjn Ferry F I B A

N Hanhart, Imp' P. C. Auld, Lith

FAÇADE.

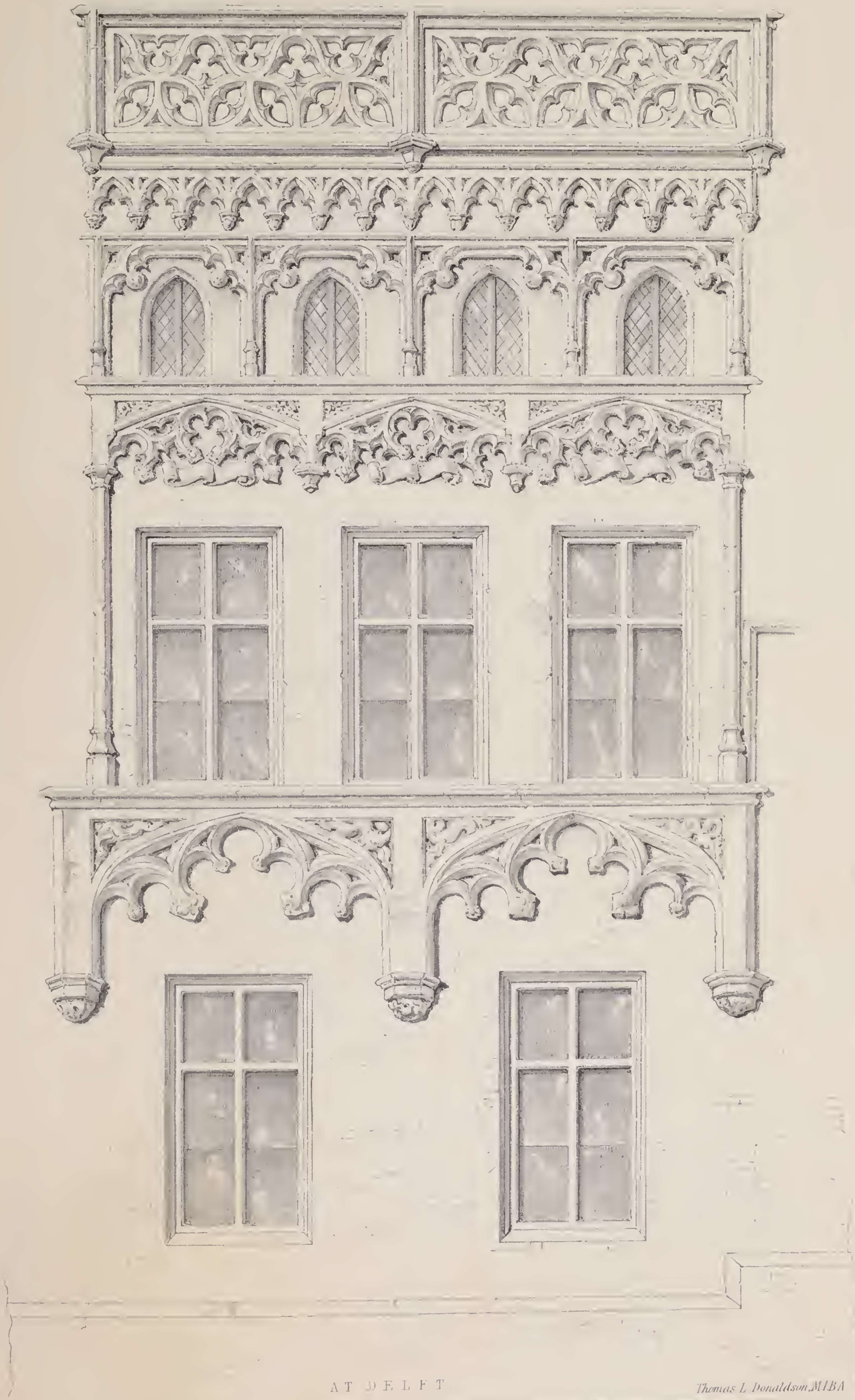


NAPLES
ANCIENT PORTAL NEAR THE ARCIVESCOVADO

ARLES
BORDERS FROM THE PORTAL OF THE CATHEDRAL OF St TROPHEME

Digby Wyatt del. & lith.

FAÇADE.



AT DELFT.

Thomas L. Donaldson, M.I.B.A.

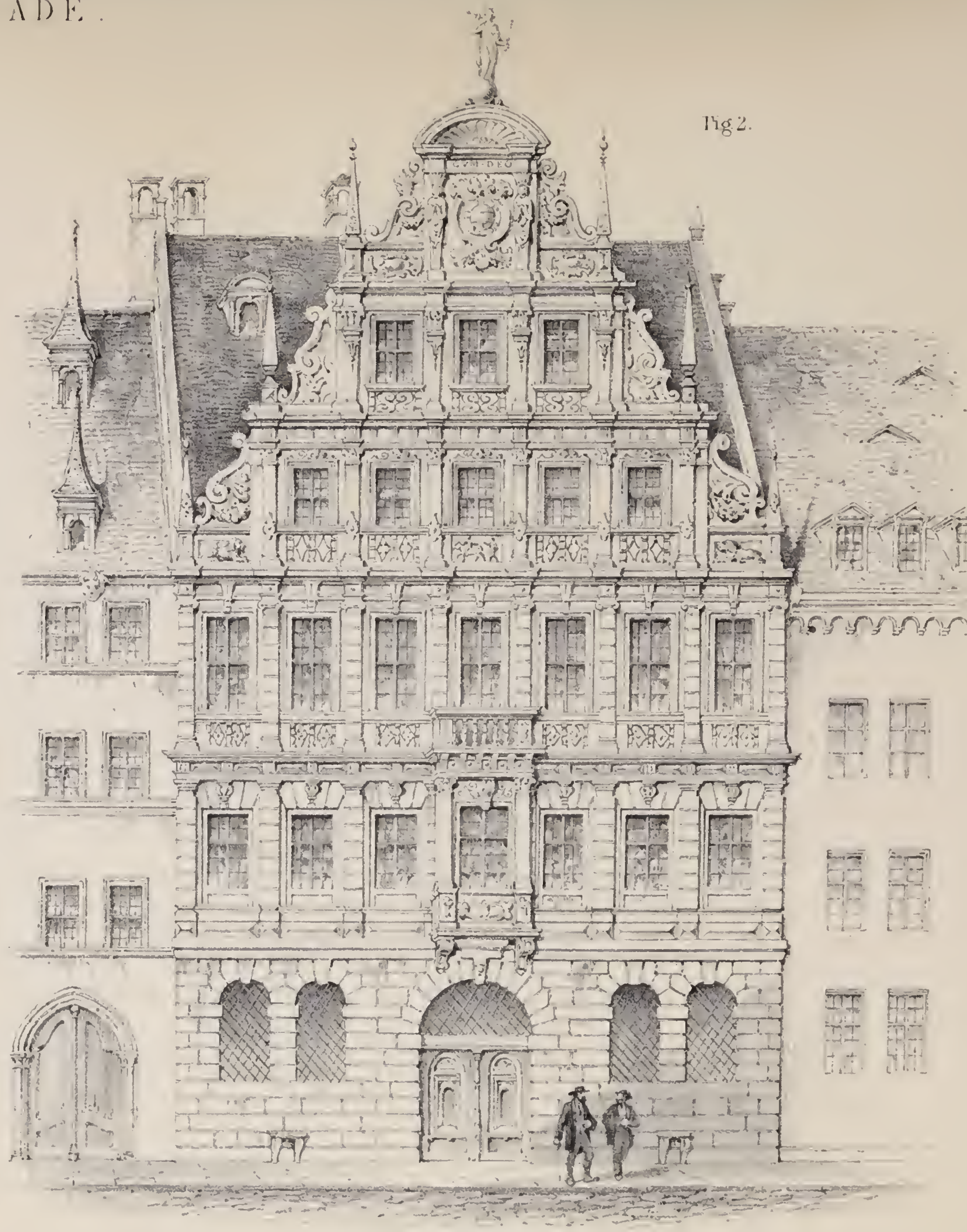
Lithographed by Mess^{rs} Day & Son May 1st 1849

FAÇADE.

Fig 1.

ROUEN.
Rue de la Savonnerie

Fig 2.

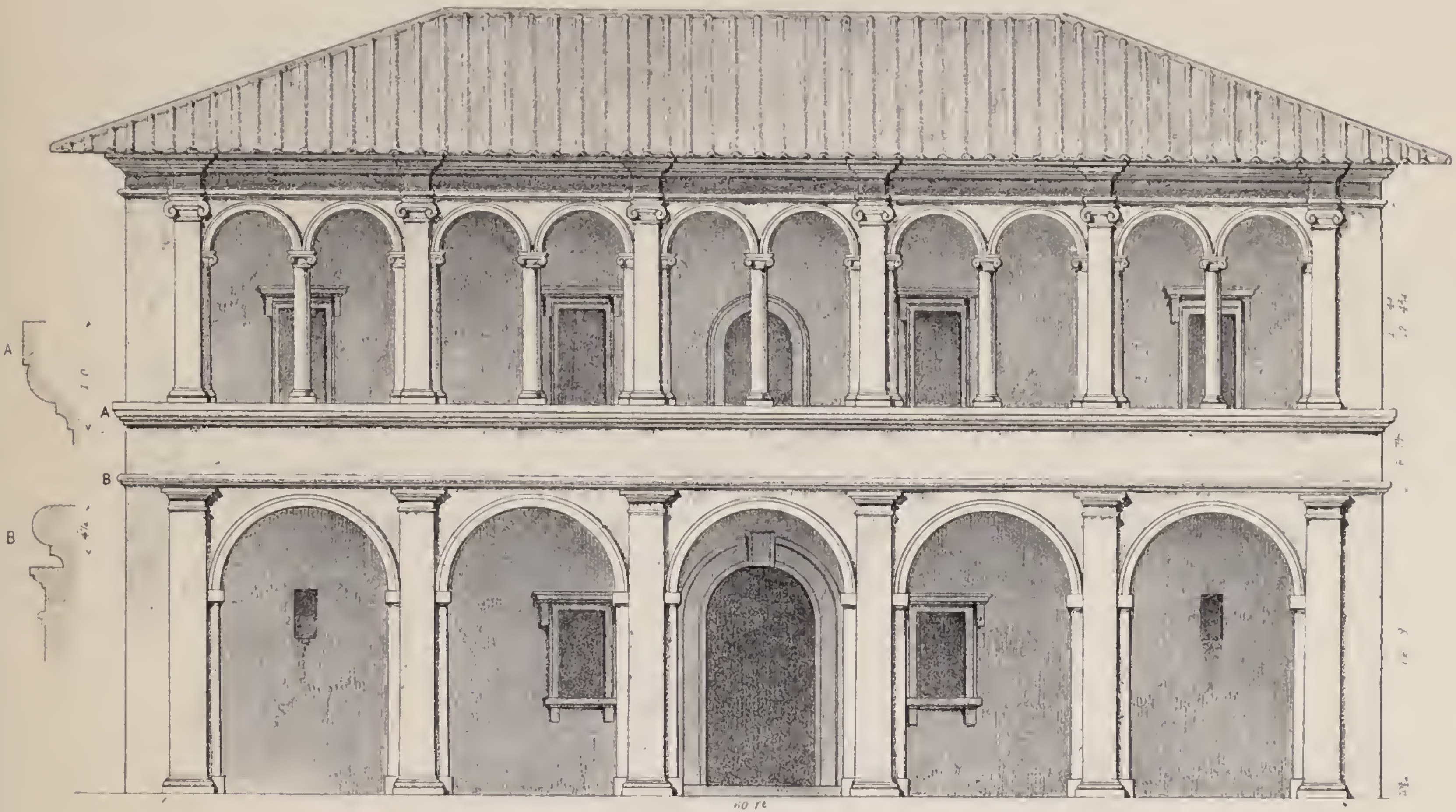


NUREMBURG.
St Giles Place.

T.H. Lewis M.I.B.A.

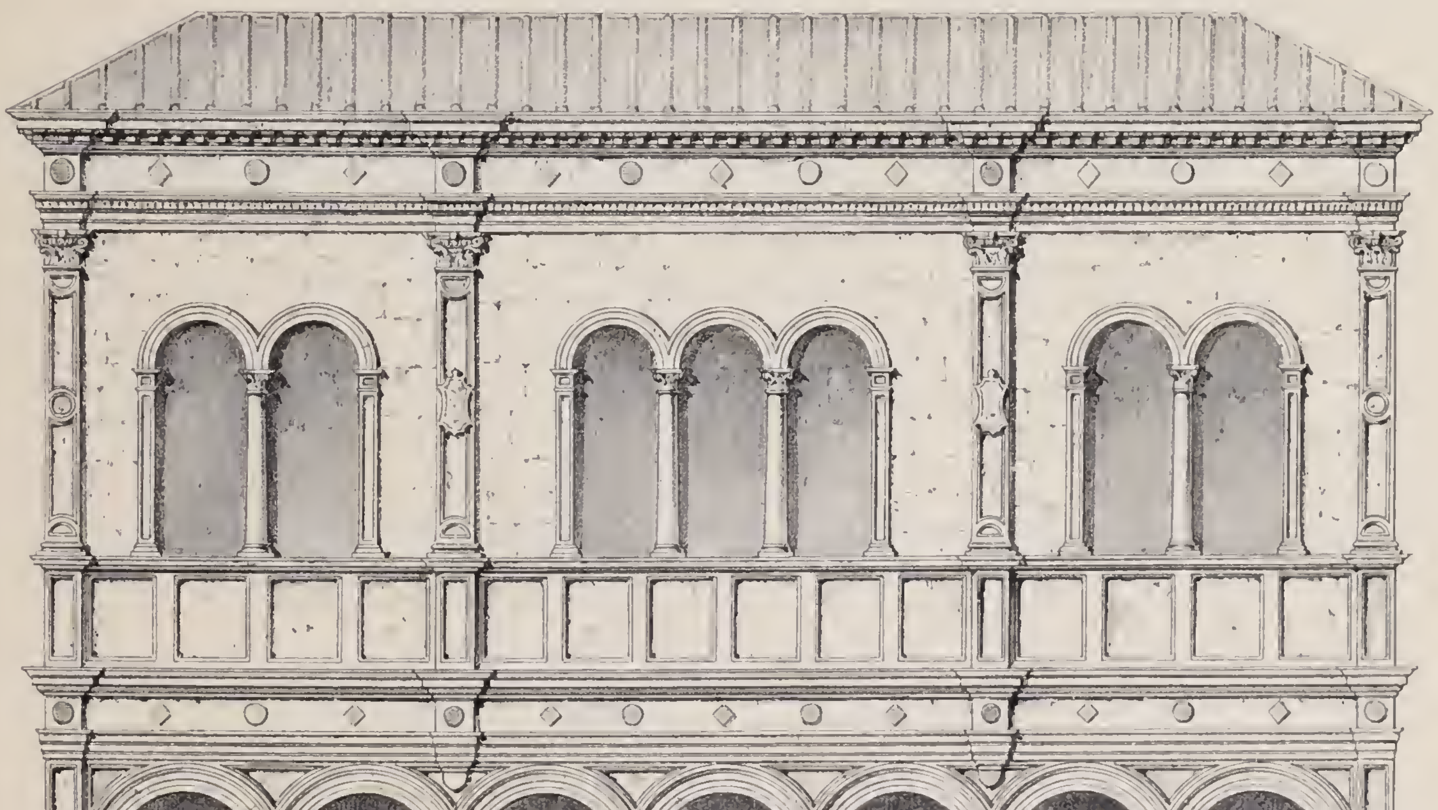
Lithographed by ... 1856

FAÇADE.



RECTORY HOUSE __ MONTE PULCIANO.

Thomas L. Donaldson M I B A

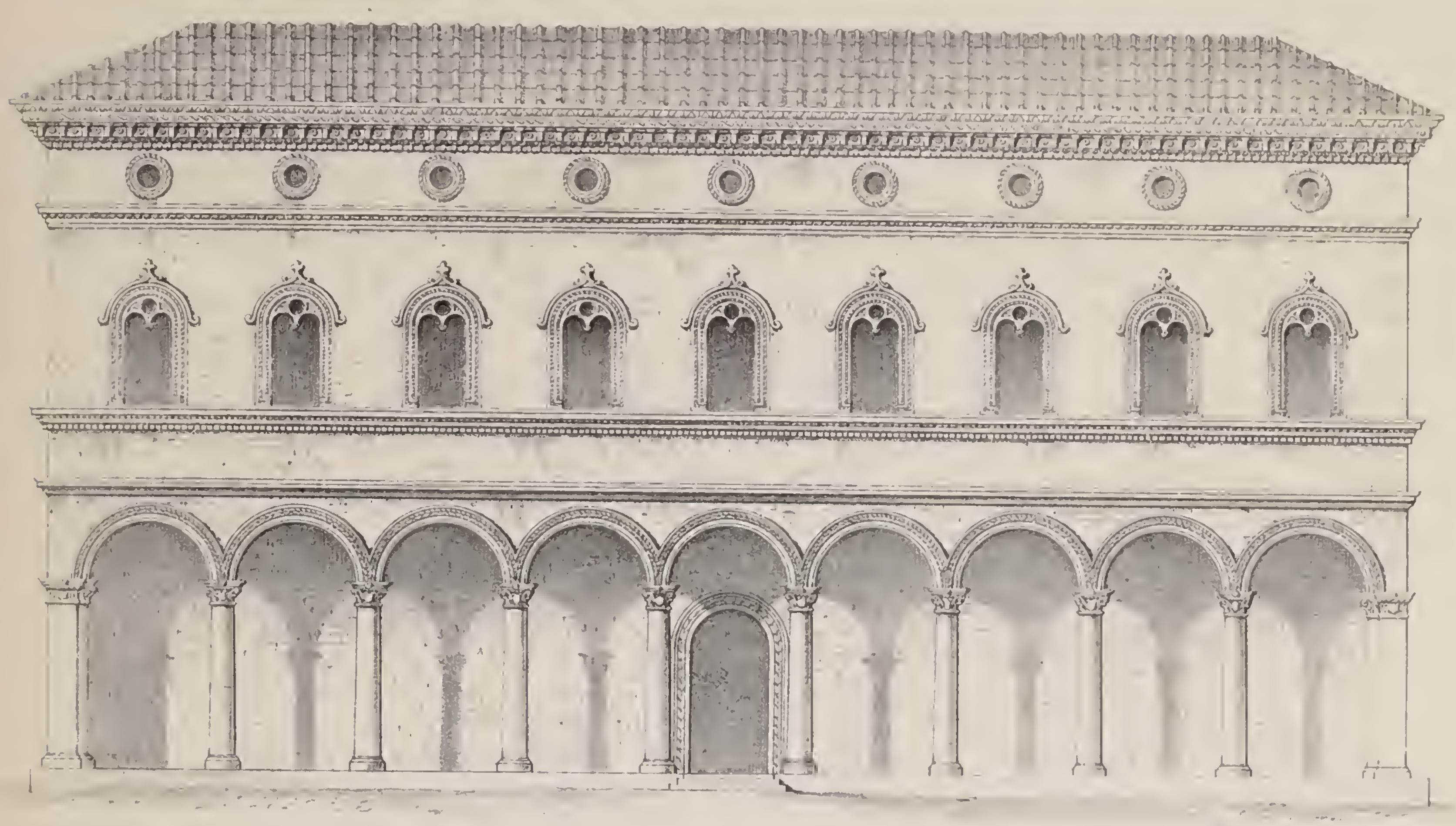


CORPO DI GUARDIA __ PADUA

R W Bensher M I B A

Lithographed by Mess^rs Day & Son April 30th 1850

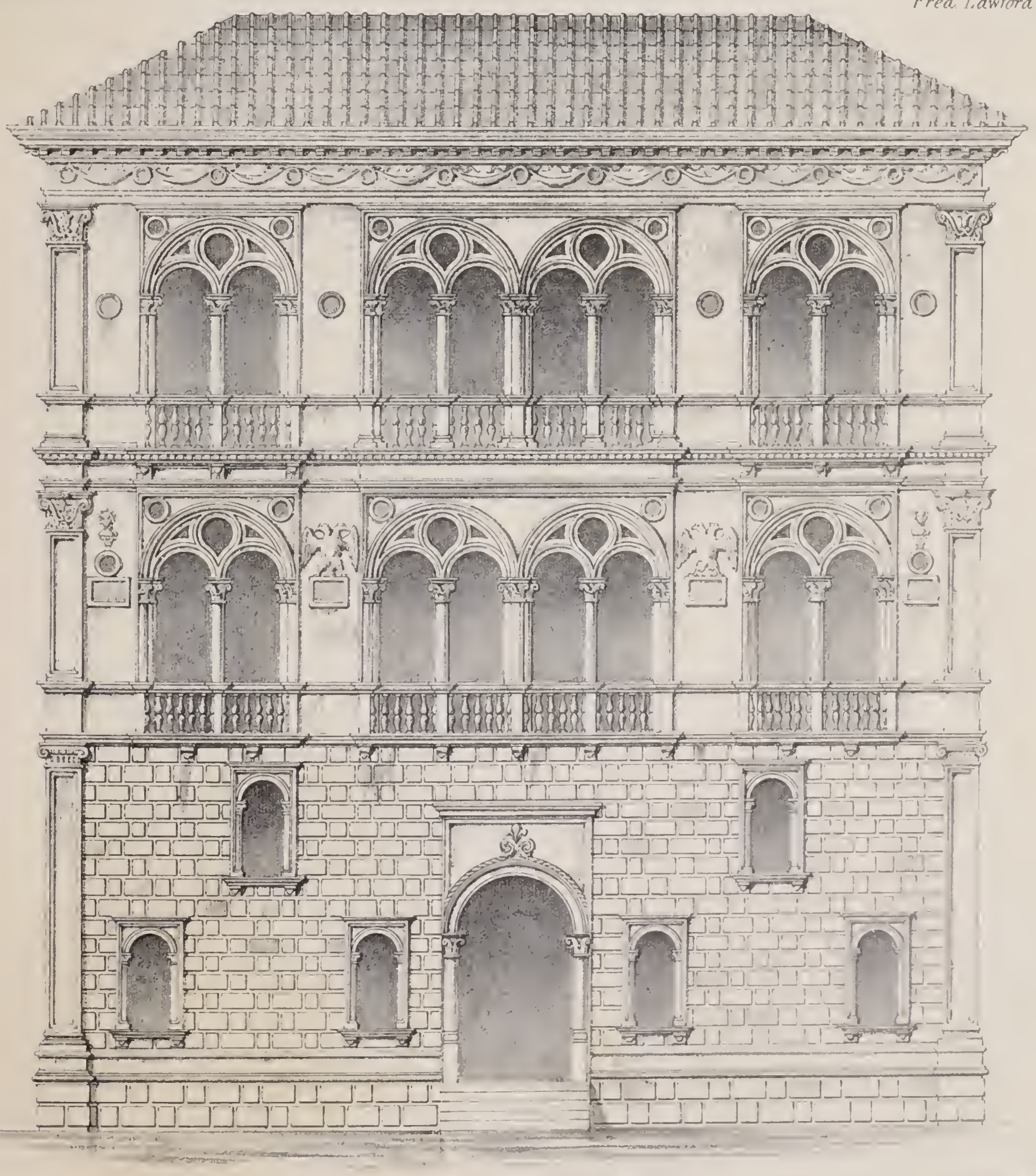
FAÇADE.



10 feet — 20 feet

PALAZZO FIBBIA _ BOLOGNA.

Fred. Lawford M.I.B.A.

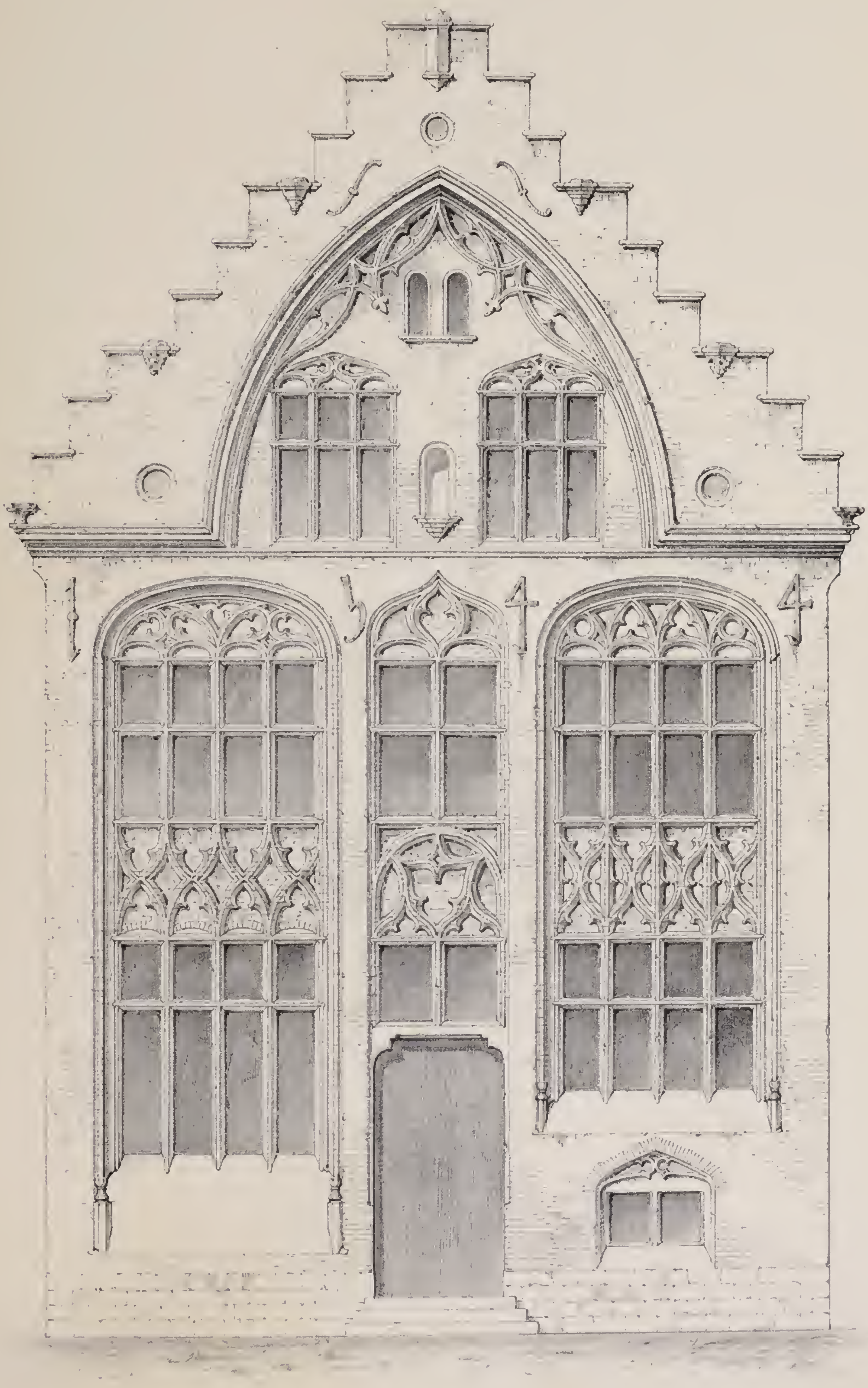


PALAZZO CORNER SPINELLI _ VENICE.

[illegible] M.I.B.A.

Lithographed by Mess.^rs Day & Son March 24^th [illegible]

FAÇADE.



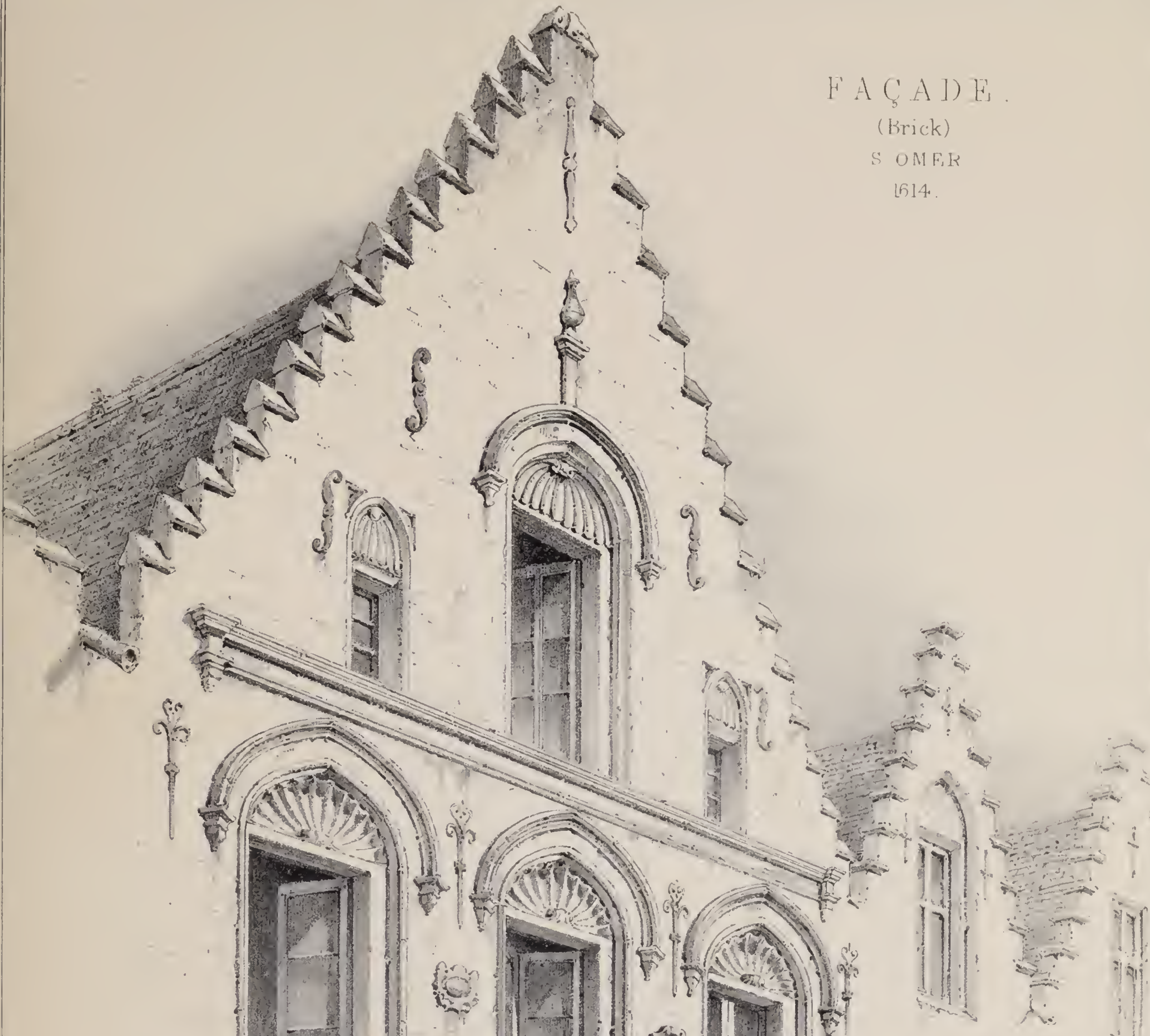
Date, the middle of the 15th Century

AT YPRES.

Edward I'Anson Junr. M I B A

Lithographed by [illegible] April [illegible]

FAÇADE.
(Brick)
S OMER
1614.



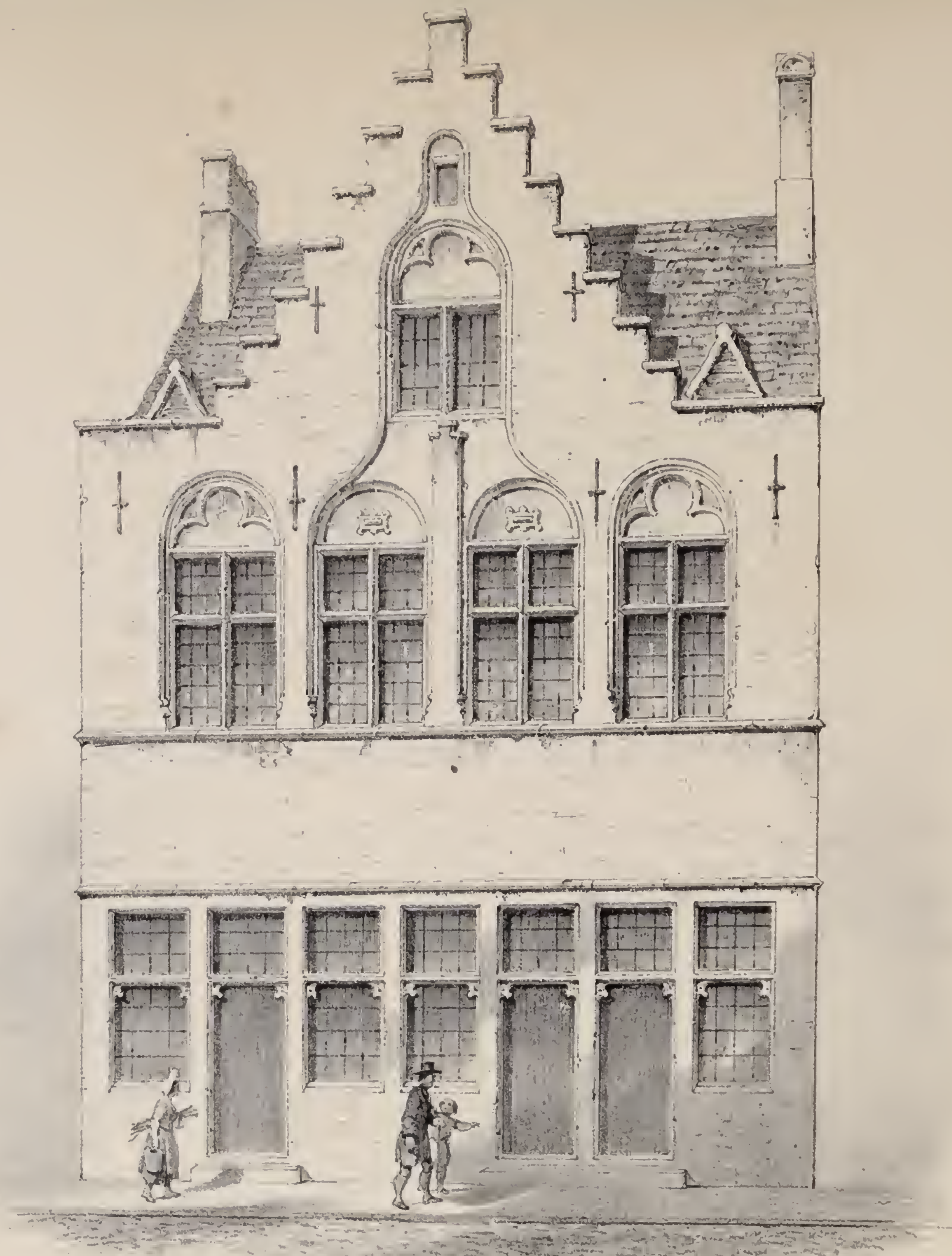
T. L. Donaldson, M.I.B.A

Lithographed by Messrs Day & Son, March 24th 1851

FAÇADE.
(Brick)
BRUGES.

A.D. 1673

T. L. Donaldson, M.I.B.A.

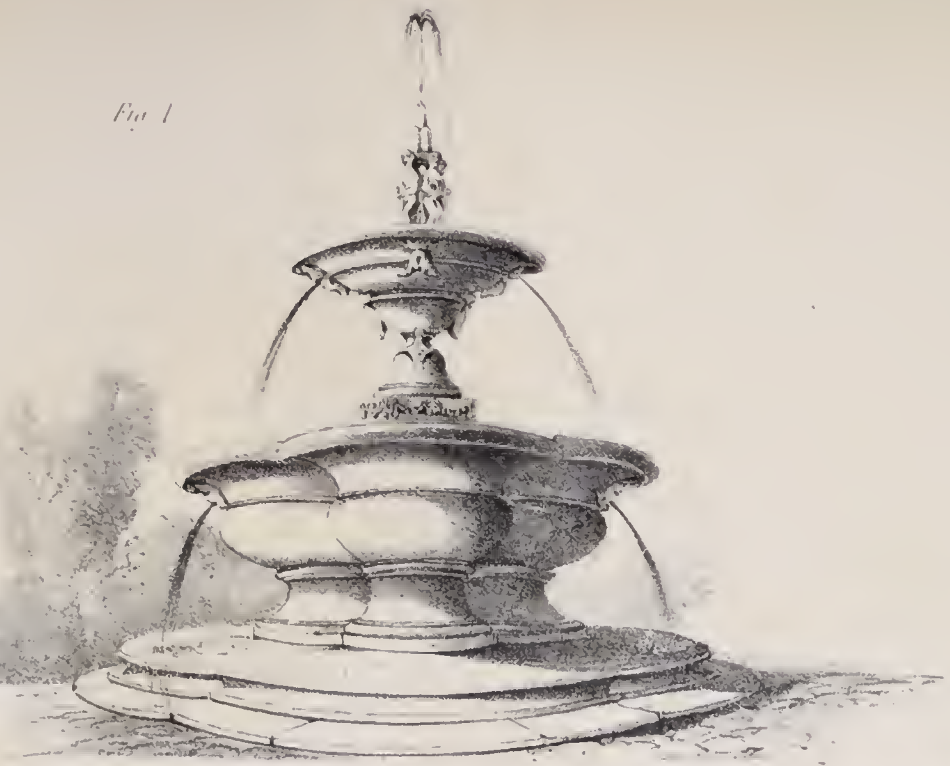


A.D. 1626

Lithographed by Messrs Day & Son, March 24th 1851

FOUNTAIN.

Fig 1



F. Lawford M.I.B.A.

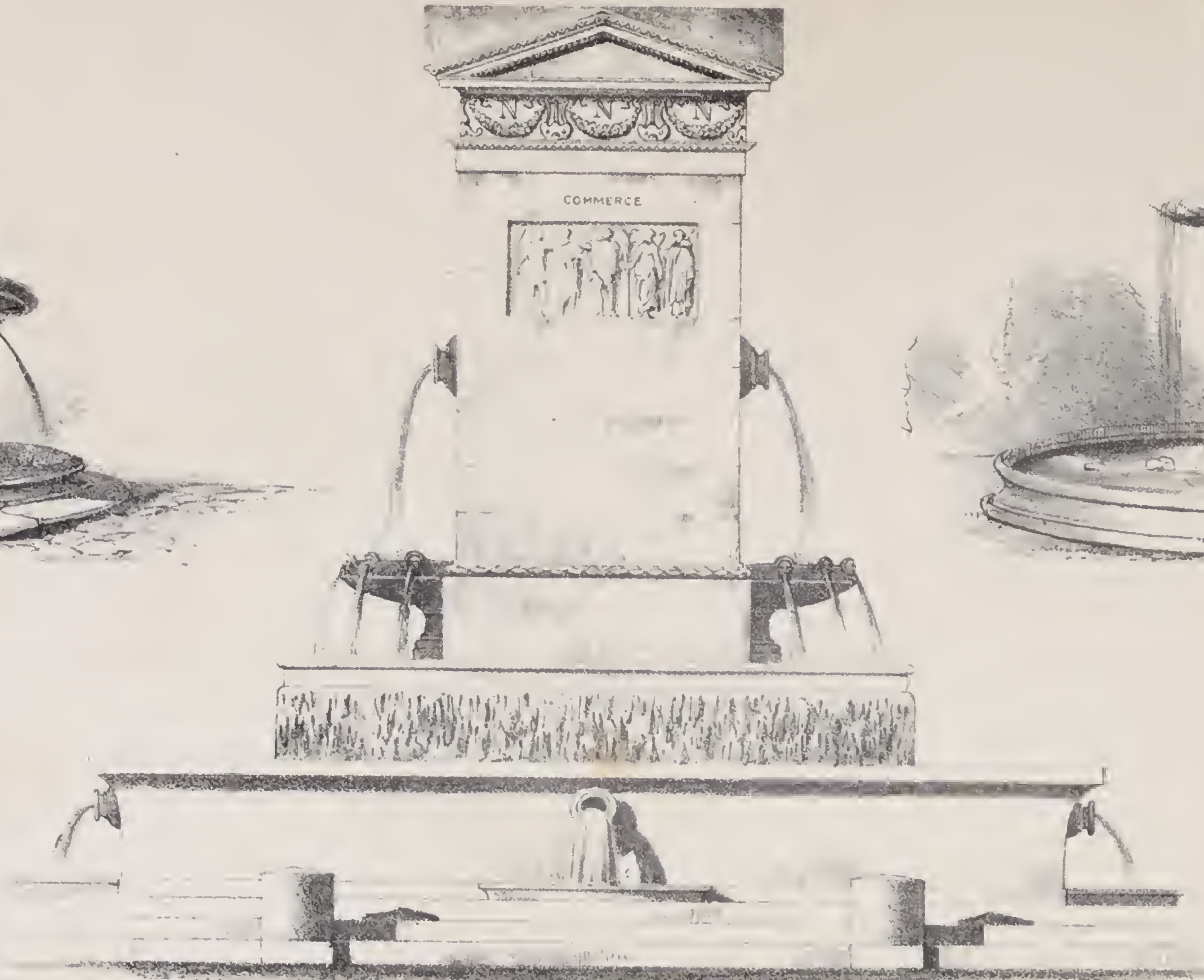
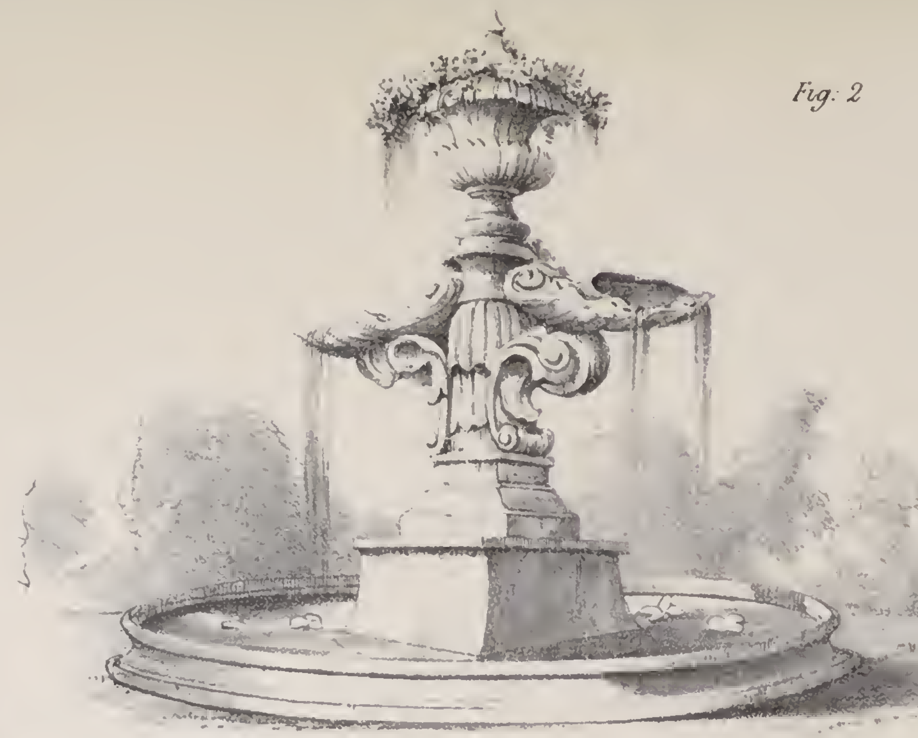


Fig: 2



M.I.B.A.

Fig 3

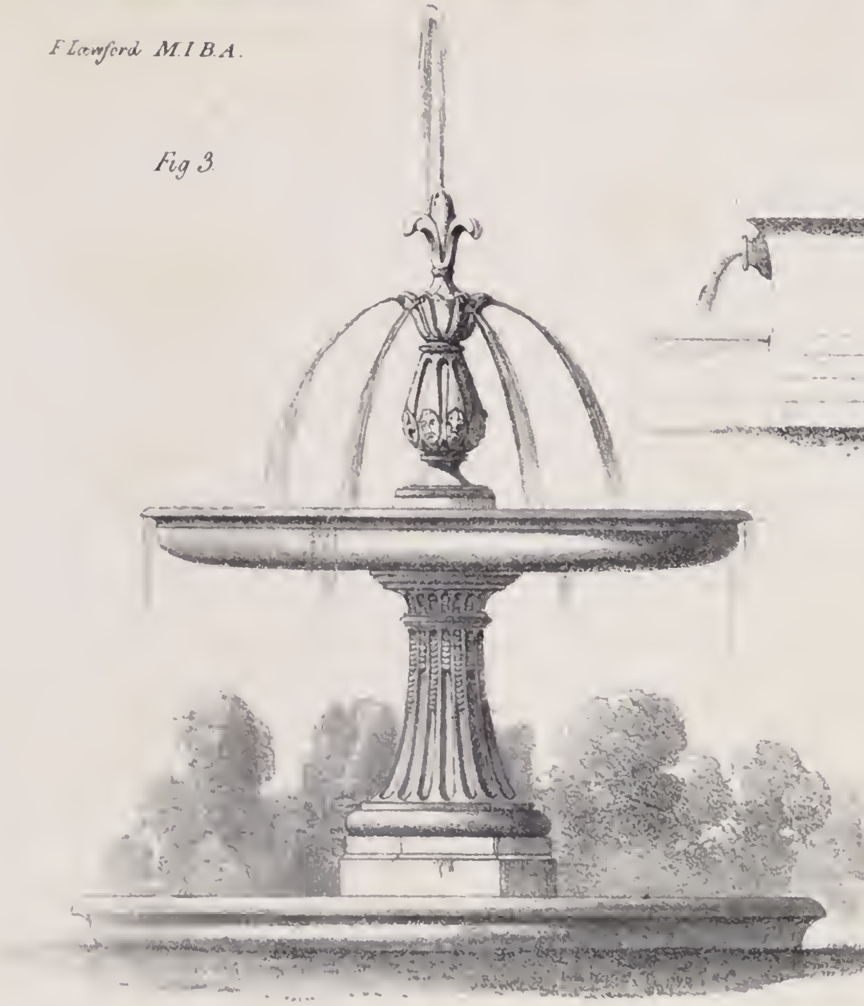
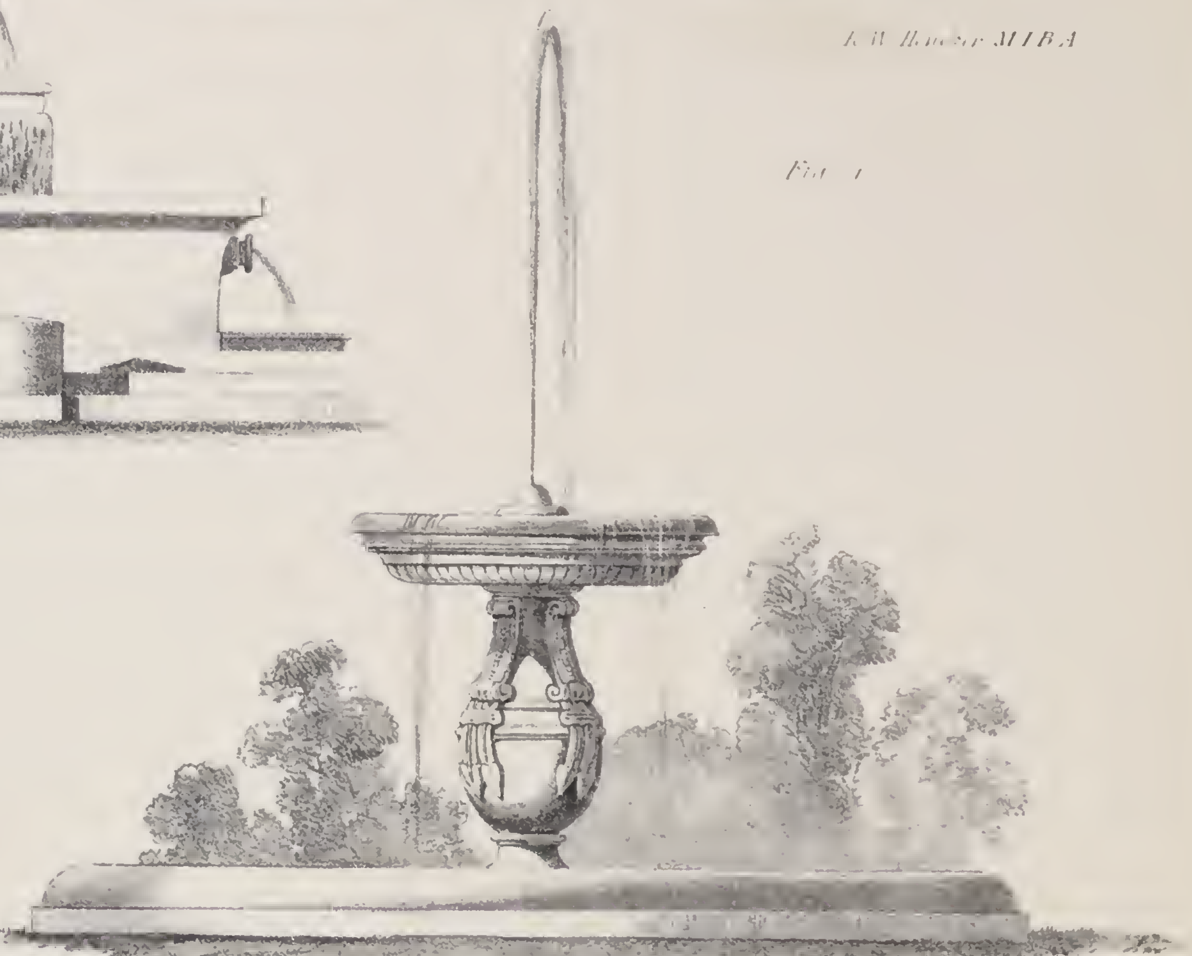
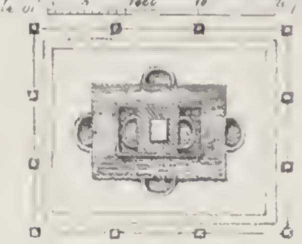


Fig 4



Scale of Feet to Elevation

Scale of Feet to Plan



FONTAINE DE LA PAIX
PARIS

Fig 1 Foot of the Capitol ROME | Fig 3 Villa Pamfili Doria ROME
Fig 2 Palazzo Caprarola ROME | Fig 4 Villa Conti FRASCATI

James M Lockyer M.I.B.A.

FULLER
ON BUILDING.

THOMAS FULLER, celebrated for his wit and fancy, and for the sound sense which he joined to uncommon powers of memory and judgment, was the son of the Rev. Thomas Fuller, rector of Aldwincle, in Northamptonshire, where he was born in 1608. At twelve years of age, he left his father's tuition for that of Queen's College, Cambridge. In that University he became B.A. in 1625, and M.A. in 1628; but afterwards removed to Sidney College, where he obtained a fellowship in 1631; and nearly at the same time, the prebendary of Netherby, in the cathedral church of Salisbury.

In 1660, he was created D.D., and made chaplain extraordinary to the King, in recompense not only for his talents, but for an unshaken fidelity, in camp and garrison, to the royal cause; in despite of which, during the existence of the commonwealth, his services were gladly accepted as lecturer, at the Savoy; S. Clement's Lombard-Street, and S. Bride's. In 1648, the Earl of Carlisle procured him the rectory of Waltham Abbey; and in that year, some writers affirm, he published the very clever work, entitled " *The Holy State*", from which a chapter is extracted. He had been a constant employer of the press from the year 1631, having produced more than twenty works, still leaving his favourite book (*History of the Worthies of England*), to be published at his death, which occurred in 1661. He was buried in the church of Cranford, where his monument still remains on the north wall of the chancel.

In the preface to a new edition, with notes, of " *The Holy State*", by JAMES NICHOLLS (Lond. 1841), are the following passages as to the history of the work:—" It was," he says, " put to press at the close of 1640, but not published till 1642. It passed through three editions in the course of ten years; but is supposed to have run through five *bonâ-fide* impressions during the interregnum,—each of them consisting of a large number of copies. In a paragraph in one of the introductory chapters to his '*Appeal of Injured Innocence*', published in 1659, he alludes to 'some design in his stationer', in suffering this work 'still to stick in the title-page at the third edition'. The (nominally) fourth edition was published in 1663, soon after the decease of the author."

The chapter itself is valuable as expressing the ideas of the features considered to be essential in buildings, at the time when the Italian style of architecture was being introduced into England by the genius of Inigo Jones; although conveying, in a very happy manner, maxims derived from an observance of the edifices erected under the influence of the taste of Elizabeth and James I.

JOHN W. PAPWORTH.

OF BUILDING.

BOOK III. CHAPTER VII.

HE that alters an old house is tied, as a translator, to the original, and is confined to the fancy of the first builder. Such a man were unwise to pluck down good old building, to erect (perchance) worse new. But those that raise a new house from the ground are blameworthy, if they make it not handsome; seeing to them method and confusion are both at a rate. In building we must respect situation, contrivance, receipt, strength, and beauty.

Of situation :—

MAXIM I.

Chiefly choose a wholesome air.—For air is a dish one feeds on every minute, and therefore it need be good. Wherefore, great men (who may build where they please, as poor men where they can), if herein they prefer their profit above their health, I refer them to their physicians to make them pay for it accordingly.

MAXIM II.

Wood and water are two staple commodities, where they may be had.—The former, I confess, hath made so much iron, that it must now be bought with the more silver, and grows daily dearer. But it is as well pleasant as profitable, to see a house cased with trees, like that of Anchises in Troy:—[1]

> . . . . . quanquam secreta parentis
> Anchisæ domus arboribusque, obtecta recessit.[2]

The worst is, where a place is bald of wood, no art can make it a periwig. As for water, begin with Pindar's beginning ἄριστον μὲν ὕδωρ.[3] The fort of Gog-Magog Hills, nigh Cambridge, is counted impregnable, but for want of water,—the mischief of many houses, where servants must bring the well on their shoulders.

MAXIM III.

Next, a pleasant prospect is to be respected.—A medley view, such as of water and land at Greenwich, best entertains the eyes, refreshing the wearied beholder with exchange of objects. Yet I know a more profitable prospect,—where the owner can only see his own land round about.

MAXIM IV.

A fair entrance, with an easy ascent, gives a great grace to a building.—Where the hall is a preferment out of the court, the parlour out of the hall; not, as in some old buildings, where the doors are so low, pigmies must stoop, and the rooms so high, that giants may stand upright.

But now we come to contrivance.

MAXIM V.

Let not thy common rooms be several, nor thy several rooms be common.—The hall, which is pandocheum,[4] ought to lie open; and so ought passages and stairs, provided that the whole house be not spent in paths. Chambers and closets are to be private and retired.

MAXIM VI.

Light (God's eldest daughter!) is a principal beauty in a building.—Yet it shines not alike from all parts of heaven. An east window welcomes the infant beams of the sun, before they are of strength to do any harm, and is offensive to none but a sluggard. A south window, in summer, is a chimney with a fire in it, and needs the screen of a curtain. In a west window, in summer time, towards night, the sun grows low and over familiar, with more light than delight. A north window is best for butteries and cellars, where the beer will be sour for the sun's smiling on it. Thorough lights are best for rooms of entertainment, and windows on one side for dormitories. As for receipt:—

[1] Virgilii Æneid, ii, 32.

[2] "And though remote my father's palace stood,
With shades surrounded, and a gloomy wood."

[3] "Water, indeed, is the best."

[4] Πανδοχεῖον, "A house for the reception of guests, an inn."

MAXIM VII.

A house had better be too little for a day, than too great for a year.—And it is easier borrowing of thy neighbour a brace of chambers for a night, than a bag of money for a twelve-month. It is vain, therefore, to proportion the receipt to an extraordinary occasion; as those who, by overbuilding their houses, have dilapidated their lands, and their states have been pressed to death under the weight of their house.

As for strength:—

MAXIM VIII.

Country houses must be substantives, able to stand of themselves.—Not, like city buildings, supported by their neighbours on either side. By "strength", we mean such as may resist weather and time, not invasion,—castles being out of date in this peaceable age. As for the making of moats round about, it is questionable whether the fogs be not more unhealthful than the fish brings profit, or the water defence.

Beauty remains behind, as the last to be regarded, because houses are made to be lived in, not looked on.

MAXIM IX.

Let not the front look asquint on a stranger, but accost him right at his entrance.—Uniformity, also, much pleaseth the eye; and it is observed, that freestone, like a fair complexion, soonest waxeth old, whilst brick keep her beauty longest.

MAXIM X.

Let the office-houses observe the due distance from the mansion-house.—Those are too familiar which presume to be of the same pile with it. The same may be said of stables and barns; without which, a house is like a city without works,—it can never hold out long.

MAXIM XI.

Gardens, also, are to attend in their place.—When God planted a garden eastward, He made to grow out of the ground every tree pleasant to the sight, and good for food (Gen. ii, 9). Sure, He knew better what was proper to a garden, than those who now-a-days therein only feed the eyes, and starve both taste and smell.

To conclude:—In building, rather believe any man, than an artificer in his own art, for matter of charges; not that they cannot—but will not—be faithful. Should they tell thee all the cost at the first, it would blast a young builder in the budding; and, therefore, they soothe thee up till it hath cost thee something to confute them. The spirit of building first possessed people after the flood, which then caused the confusion of languages, and since of the estate of many a man.

FURNITURE
CANDELABRA — DESK — TABLE.

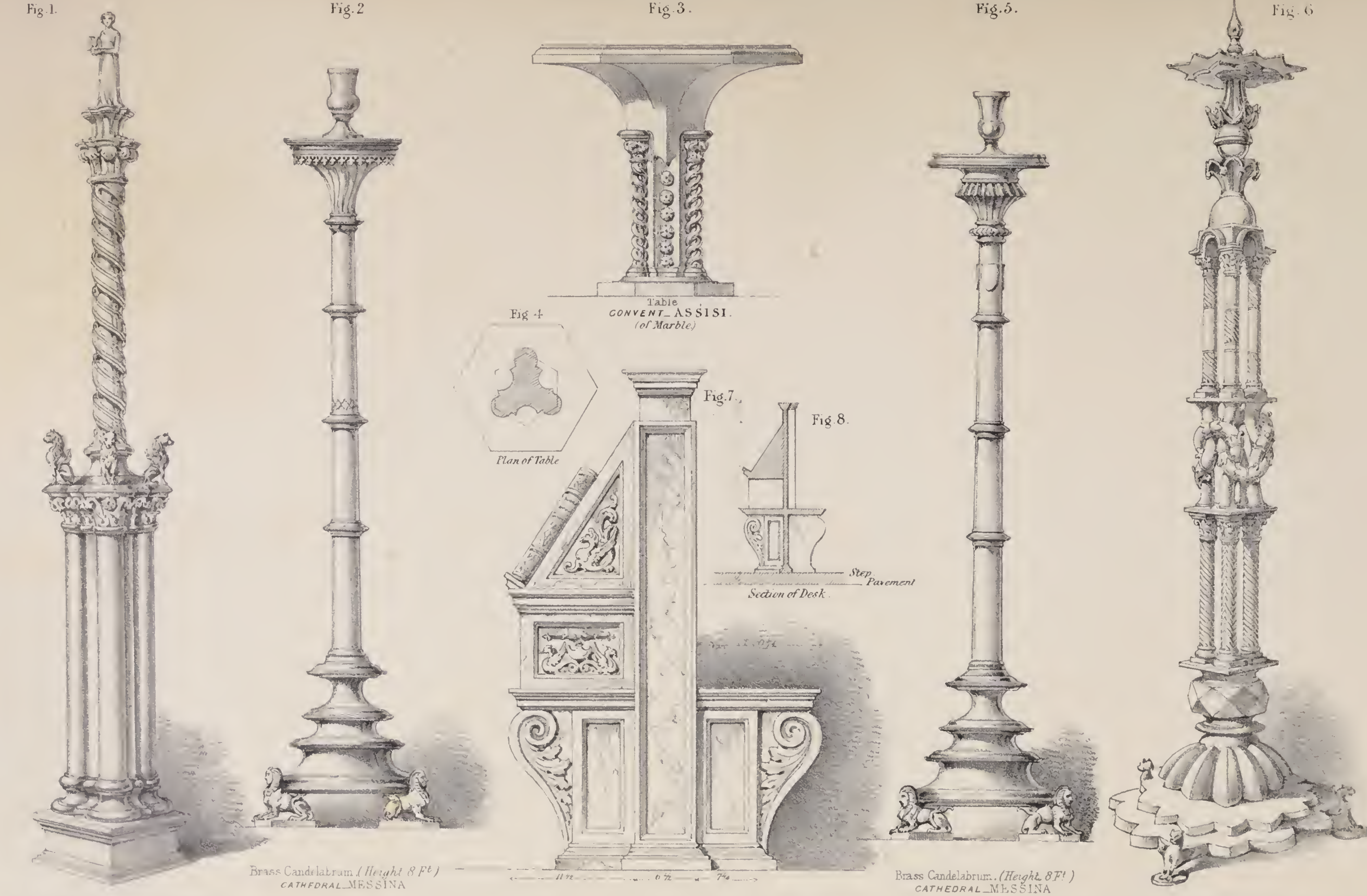


Fig. 1. Marble Candelabrum (Height 13 Ft.) S. MICHELE — FLORENCE

Fig. 2. Brass Candelabrum (Height 8 Ft.) CATHEDRAL — MESSINA

Fig. 3. Table CONVENT — ASSISI. (of Marble)

Fig. 5. Brass Candelabrum (Height 8 Ft.) CATHEDRAL — MESSINA

Fig. 7. BIBLIOTECA LAURENZIANA — FLORENCE. Manuscript Reading Desk

Fig. 6. Bronze Candelabrum (Height 6 Ft. 1 In.) S. GIORGIO MAGGIORE — VENICE.

Sydney Smirke M.I.B.A. A.R.A.

Lithographed by Mess. Day & Son Jan. 28th 1850

A DESCRIPTION OF SOME

BRICK GABLES

TO COTTAGES IN BROADSTAIRS, NEAR RAMSGATE, AND IN THE NEIGHBOURHOOD.

Throughout the whole history of our art, there seems to have reigned an antagonism of two principles: the useful and the decorative. Each has had the predominance at various epochs. The most fortunate periods of architecture were those, when the two were happily united, and satisfied at once the wants and tastes of mankind. This contest is going on at the present moment; many considering the ornamental as the chief aim and end of a building, others deeming all decoration of very minor importance, and in some constructions very ill-placed.

One of my own maxims is that *ornament is use*. For the life of man is not given him merely to provide for the animal wants of his existence, but to enjoy life; and the sphere of his enjoyment will be enlarged, as he is taught to appreciate the beauties of form, of colour, of proportion and contrast, of light and shade. This enjoyment is forbidden to no class, and may be the property of the humblest as of the most elevated. It is a simple fruition, which has the whole range of nature for its objects of contemplation,—the hill, the dale, the sea, the land, the starry glories of the sky, the varied beauties of the flowery meadow, and, as Cowper says,—

> "He looks abroad into the varied field
> Of nature, and though poor, perhaps, compared
> With those whose mansions glitter in his sight,
> Calls the delightful scenery all his own.
> His are the mountains, and the valleys his,
> And the resplendent rivers."—*The Task*, book v.

And art itself swells the catalogue, in the splendour of the palace, the solemn dignity of the church, and the cotter's humble dwelling. For this last, with the commonest materials, may be made to assume an infinity of varied forms, to charm the most refined, as well as the humblest taste, without diminishing one of its comforts as a residence. It must have been evident to all, that the country village of modern times has lost much of the picturesqueness of mediæval periods, by the abandonment of the gable ends, and the adoption of hipped roofs. In the former there was a bold decision of form, a height of elevation and pyramidal outline. In the hipped roof there is a tameness and insipidity, and a prevalence of the horizontal, instead of the vertical lines. The flatness of the roof of modern times also does not admit of those gable windows, breaking through the horizontal line of the dripping eaves, varying the outline and giving the conviction of the usefulness of the high pitched roof, as a quality independant of, yet associated with, its innate element of beauty.

The variety and pleasing forms of the gable ends of some of the houses in Broadstairs, and in its immediate neighbourhood, as S. Peter's, Reading Street and Sole Street, are very striking.

The construction is simply of brick and flint, and the two materials are so ingeniously combined as mutually to set off each other. Some of the houses are of one story, with a high pitched roof, containing rooms within it. Others have two lower stories with the range of attics in the roof also.

The gable ends rise with a bold pitch, the contour formed at one time with a simple ogival profile on either side and a central mass rising up, crowned by a circular or pedimental top; and this again surmounted by a massive chimney shaft, as Figs. 1 and 2.

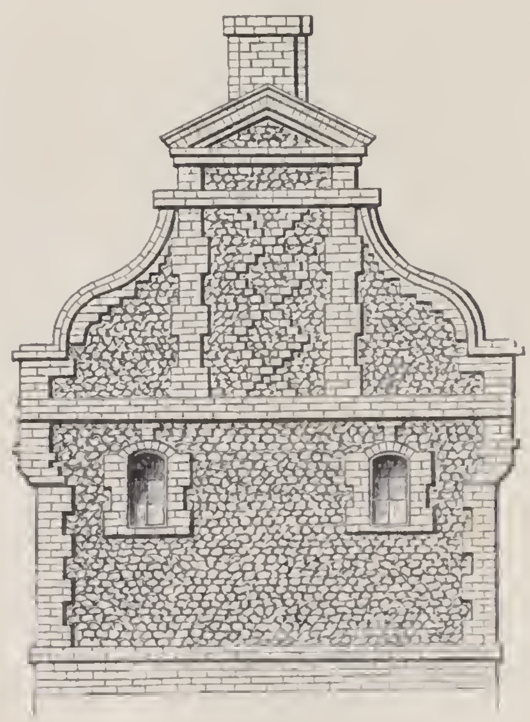


Fig. 1.

HIGH STREET N° BROADSTAIRS

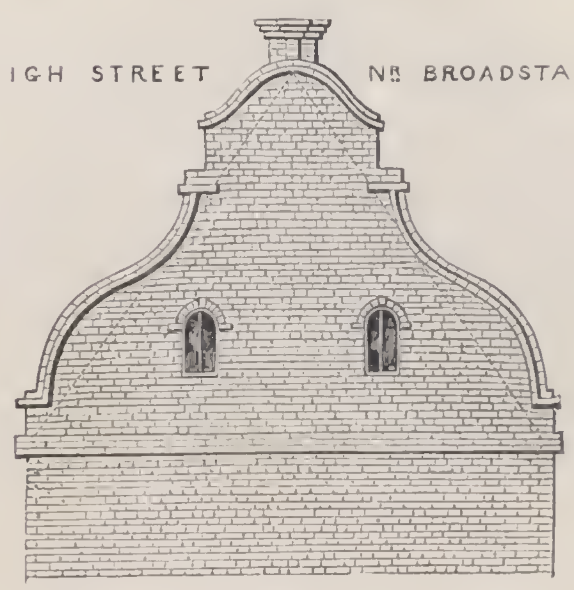


Fig. 2.

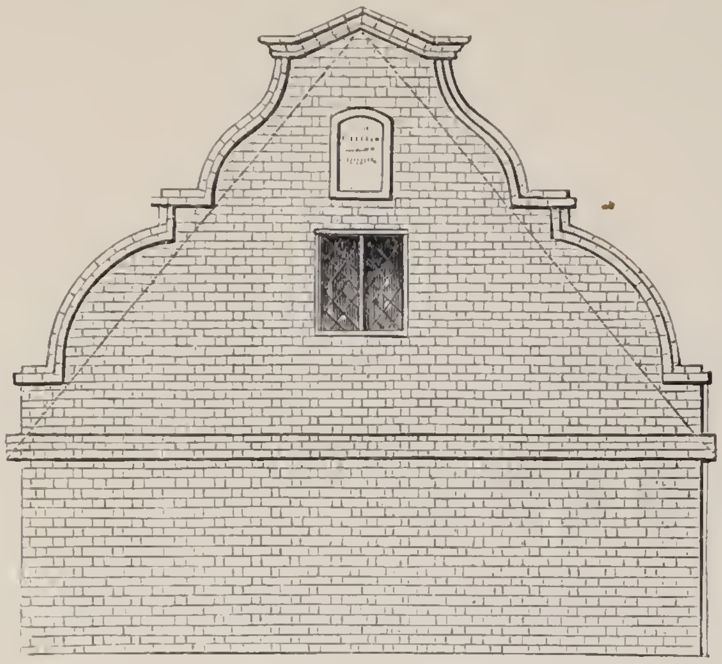


Fig. 3.

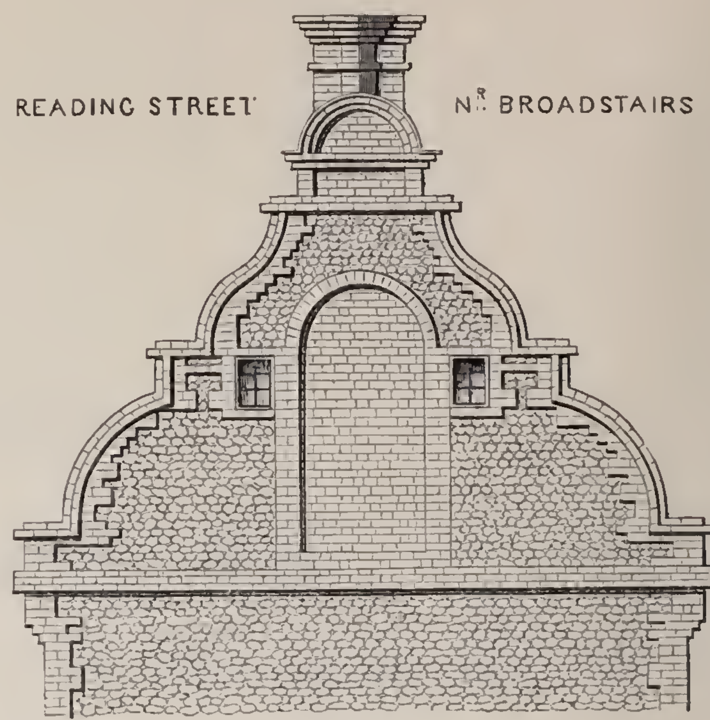


Fig. 4.

Fig. 5.

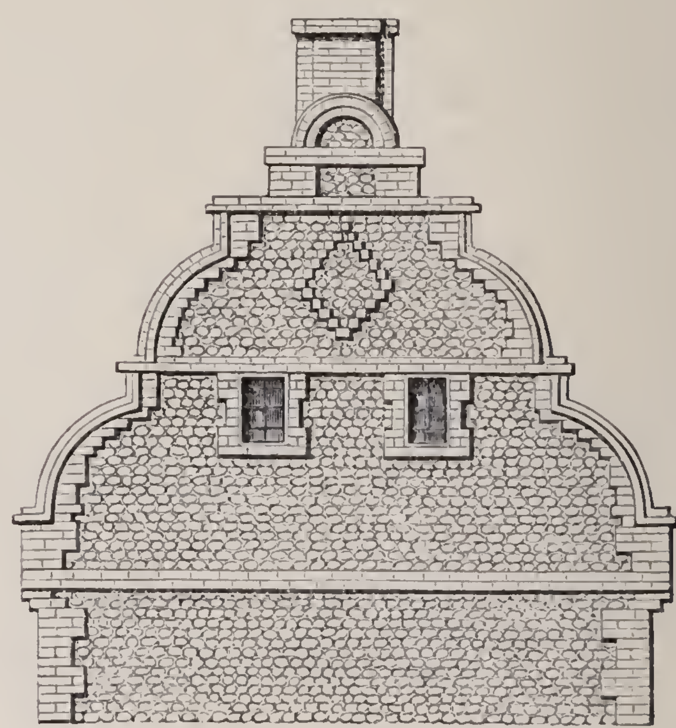


Fig. 6.

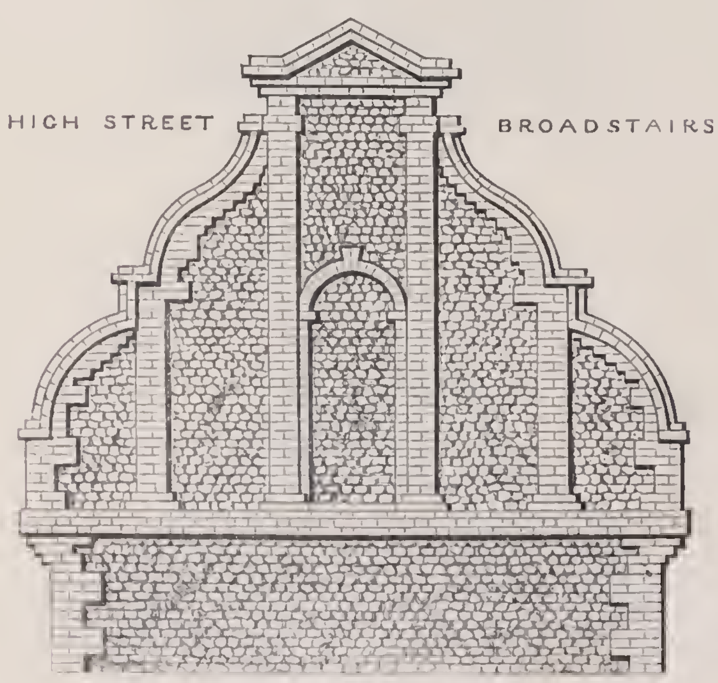


Fig. 7.

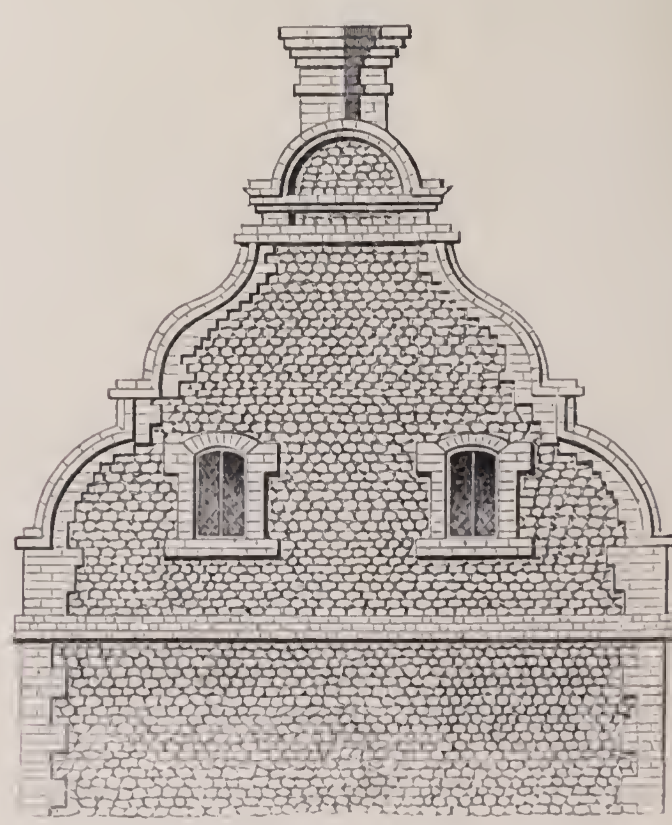


Fig. 8.

At other times the outline of the gable is broken into two heights by a quadrant as well as an ogee, with the usual centre somewhat varied, as Figs. 3 and 4. Another variety consists of five segments, as Fig. 5. The outline is generally formed by a simply projecting brick, as a cresting, beneath which the bricks are not cut to the sweep, but are arranged whole, to come in as they will.

In the upright parts, below the gable, when the mass of the construction consists of brick and flint work, it generally occurs that the quoin of the building is formed with a species of rusticated or alternating blockwork, nine inches high each course, and alternately nine and fourteen inches wide. The flint-work occupies the general surface, and is arranged in regular courses of the same height as the brickwork, of three inches each. There is an horizontal string generally at the commencement of the gable, three courses high, which projects about an inch or an inch-and-a-half, stopping short of the ends, as Figs. 6 and 9, about nine or fourteen inches, and returning on itself: or going to the end, and not returning along the other front. Occasionally, there is another intermediate horizontal narrower string in the height of the gable, being the cresting carried through (as in Fig. 6, Reading Street example). Sometimes the gable is divided by vertical piers or pilasters in brickwork, as in Fig. 7, either slightly projecting beyond the face of the flint-work, or at others not at all; the bricks themselves, by the contrast, marking the feature.

Now and then, in the centre, there is an arched panel slightly sunk, with or without an impost, as in Figs. 4 and 7.

The windows are generally small, with a brick margin and with slightly arched heads; the outside line of the margin being indented, and the sill indicated, and occasionally with the springer somewhat projecting.

Here and there, for effect, even blank windows or panels are introduced, as in Vowel's Cottage, Figs. 9 and 10. The square masses of the chimney shafts tell with great effect. They have

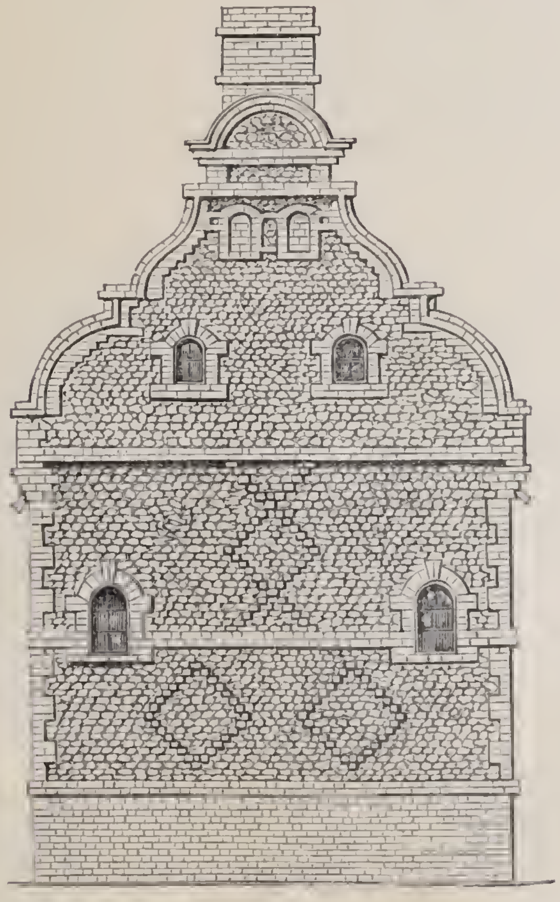


Fig. 9.

projecting courses, and the head is formed of several oversailing courses. In the centre, there is now and then a square projection, as Figs. 1, 2, and 6; and at times an angular one, as Figs. 4 and 8. In fact, the fancy of the designer seems to have revelled in a playful variety of the parts, which, although presenting a general likeness, is so artfully combined in one or other of the details, as to offer an endless change of effects.

It will be perceived, that the general surface of the work is varied by the introduction of lozenges and other figures, formed by brick headers in the flint-work, as Figs. 1 and 9.

In only one instance is there to be found a return front which had not been materially altered by modern innovations. This is in Reading Street, Vowel's cottage, Fig. 10. It is irregular in distribution, but still a certain eurythmy is preserved.

Fig. 10.

There is a door at either end; probably one of these was originally a window, and has been cut down to form a door, in order to convert the cottage into two dwellings. The heads of the doors and large lower window are elliptic; a form very prevalent. The brick margins round the opening are very peculiar, with the alternating broad and narrow courses and projecting imposts, as also the central keys to the arched heads, and the margins continuing vertically up to the string. Out of the six windows, there are four varieties of size or form. In this instance, the long line of the dripping eaves is not broken by a gable head to any one of the windows, which might have improved the outline. Nor is there any gable window in the roof, as the rooms in the roof are lighted by small windows in the gable ends of the cottage.

Here, then, without any material expense in the construction, without any application of costly material, is an elegant fisherman's cottage; striking in its proportions and outline, designed with care, and producing a pleasing effect to the eye. There were some beautiful flowers trailed against the front, and planted in the beds. A well formed neat pathway led to the doors, and there was an abundantly stocked garden of a few perches in extent, which amply supplied the fruit and vegetables to the occupants. Is it then too much to assume, that the taste evinced in the arrangement of the garden may have been influenced by the architectural elegance of the habitation, or to believe that these poor people were the happier and the more refined from being housed in a dwelling, where the hand of taste had added elegance to the rural comforts of the hard working, simple cottager and his family.

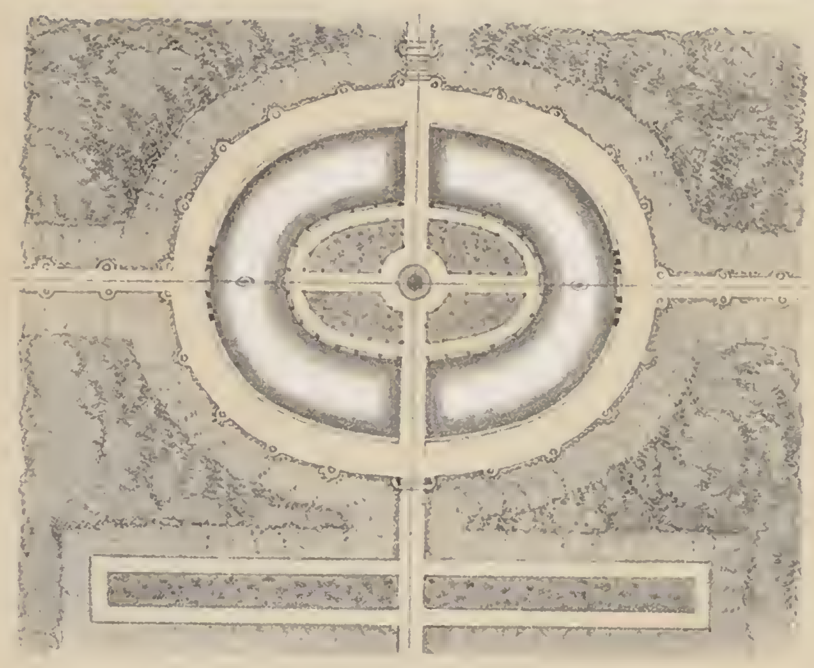
T. L. Donaldson.

GARDEN

Fig 1

Fig 2.

Figs 1 & 2
Plan and View of
L'ISOLA BELLA



in the BOBOLI GARDENS
FLORENCE

50 0 100
Scale of Feet

Fig. 3.

MONREALE

Sydney Smirke A.R.A.

London Lithographed at 70 St Martins Lane Febry 2d 1852

GATEWAY.

A. J. Green M.I.B.A

PALAZZO DURINI

PORTA PIA, ANCONA
(VANVITELLI)

Sydney Smirke. M.I.B.A. A.R.A

GENOA

STRADA NUOVA

Sketched by E. W. Cooke A R A

London Lithographed at 70 St Martins Lane Febr.y

GERBIER

ON THE

THREE CHIEF PRINCIPLES OF MAGNIFICENT BUILDING.

Sir Balthazar Gerbier, Baron D'Ouvilly, has been very much undervalued by the compilers of Biographical Dictionaries, of whom not one appears to have consulted the account which he gives of himself, in the pamphlet entitled "Balthazar Gerbier, Knight, *to all men that love truth*" (dated, in a MS. note, *Paris*, 26 *May*, 1646), from which it appears that he was a child of Huguenot refugees—Antoine Gerbier, a gentleman by birth, possessed of a barony in Normandy, and Radegonde, daughter and heir to the Lord of Blavet, in Picardy.

He was born at Middleburg, in Zealand, about the year 1591; was educated, by his brother's means, in France; and returned to Holland in time to accompany Caron, the Dutch ambassador, to England. There he made his attendance pleasing to the famous George Villiers, on account of his "several languages, good hand in writing, and skill in sciences,—as mathematics, architecture, drawing, painting, contriving of scenes, masques, and entertainments for great princes; besides many secrets gathered from divers rare persons; as likewise for making of engines useful in war."

Sanderson (*Graphice*, p. 15) calls him "a common penman, who pencilled the Decalogue in the Dutch Church, London, his first rise of preferment." Gerbier himself states, "the Duke of Buckingham put to me first, the contrivance of some of his habitations, and to choose for him rarities, books, medals, marble statues, and pictures in great store; I kept his cyphers with his intelligencers abroad, and was sent by him (with the King his master's approbation) on secret messages."

His services on one of these occasions were required by the Duchess, who in one of her letters (*Harl. MSS.* 6989) to her husband, at Madrid, 16th July, 1623, wishes him, that she might have it well done, to sit for his portrait, in little, to Gerbier, who had followed him in quality of painter in distemper, and had executed a miniature of the Infanta for King James.

His public employments abroad, were, his journey into Holland, to receive overtures for the restoration of the Palatinate; a mission to expostulate with Richelieu, on the behaviour of the French cabinet with respect to Count Mansfeldt; a conference with the Marquis Spinola, in Brabant, "on which the treaty with Spain was set on foot, and pursued until it was brought to a conclusion"; and to remonstrate at Paris, on the carriage of Spanish goods in French vessels. When Blinville, the ambassador, had contrived to excite a riot in London, Gerbier was ordered to make a drawing of the locality in which it occurred, to enable Buckingham to explain the matter to his master, by whom Gerbier was again sent to the French court. He then delivered to Richelieu that letter from the Duke, which is unnoticed in the history of our country, but was probably the most important document of the period, because the two favourites then declared their opinions of each other, which were so violently expressed by the cardinal, that to revenge himself, for the necessity of making an apologetical oration, he instigated and fomented those parliamentary troubles for Buckingham, which ended as fatally for the King.

Walpole (*Anecdotes of Painting*, vol. ii) gives a copy of one of Gerbier's letters, dated from the Hague, 6th August, 1627, in which Rubens's name appears as appointed to meet him on the subject of the Spanish treaty.

Buckingham desired that the feast of reconciliation between himself and the Abbé d'Escailles (della Scaglia), should take place at Gerbier's house, "where the Duke was pleased two days after, to beseech his Majesty to come with the Queen to accept like entertainment, because the manner thereof was pleasing." This supper is mentioned in a letter of 1628, as taking place at the Duke's painter's house, and was supposed to have cost a thousand pounds. He was knighted, 31st March, 1629, at Greenwich, probably on occasion of being made Master of the Ceremonies, and for eleven years after was resident at the court of Brussels, acting the part of an accomplished minister, as it was then played; as witness the reply, "it is not my custom to disgrace those that do serve me well", made to an address of the Spanish embassy for his removal, by Charles I, who seems to have had a great esteem for his works, as well as for his other services; this may be inferred from the letters of the King, and from the consideration, that such a connoisseur would not have insulted the talents of Rubens and Vandyke, by joining them in the same honor with a man of inconsiderable talent.

In 1637, he was sent on a mission to the discontented Duc d'Orleans: and on the 13th of July, 1641, he took the oaths of allegiance and supremacy, having obtained a bill of naturalization; but this watchfulness was not sufficient to protect him from being troubled in the following year by the populace, as a papist and concealer of priests; this seems to have driven him abroad; and going from the Hague, in 1645, he received from Charles a letter of credence to the French King, containing the following passage:—"I do recommend this gentleman, master of my ceremonies, to your particular protection, for that he hath done me long and faithful service." This was answered by a gift, in consideration of his detection, when at Brussels, of a plot on the part of the Duc de Bouillon, against the King's life. He says, that he received the superintendence of an office, which would have proved worth many thousand pounds a year, but that he was pursued by a faction, who maintained, in petitions presented by the Bishop du Puis to the Queen Regent, that she was, *ipso facto*, excommunicated, for bestowing such an office upon a heretic.

He lost his post; and the best light of his character is displayed in his efforts to obtain the return to his own care, of three daughters who were induced to conform to the Church of Rome, placed in a nunnery, declared to belong to others, and refused permission to have an interview with him.

Returning to his house in Bethnal-Green, he opened an academy, in imitation of the Museum Minervæ, of which he put forth an account, having his portrait in an oval, prefixed. Public lectures, of which nine are printed, were given on Wednesdays, until March 1650, as appears by his advertisements; in one of which, he professes to lend "from one shilling to six, gratis, to such as are in extreme need, and have not wherewithal to endeavour their subsistence, whereas, week by week, they may drive on some trade."

The publication by him of some well-intended pamphlets, shows, that he did not quit England until after 1652, when (having previously obtained a grant, during his residence at Brussels and the Hague, to settle in Cayenne) he went to Surinam; there, however (7th May, 1660), by permission of the Dutch governor, his house was broken open, the assailants killing his daughter Catherine, and endangering the lives of others, his papers seized, and he himself, menaced with a loaded pistol held to his head, unable to resist, was, with his family, put on board a vessel bound for Holland. On his arrival there, he complained, but obtained no redress; the States disowning both the act, and any pretended orders for it. As this happened immediately before the Restoration, they apprehended, knowing his obligations to England, that he might give notice of the advantages to be gained in Surinam.

This, in effect, *was* his revenge; his publications had a share in rousing Charles II to declare war with the Dutch; having no other recompense for his sufferings, after a life of many vicissitudes, he ended as he began, by the exercise of his professional skill; first, as asserted by Gough (*British Topography*, vol. i), in designing the four triumphal arches for the coronation procession at the Restoration; and afterward, on the erection of the Lord Craven's house at Hempstead-Marshall, in Berkshire, since destroyed by fire. Representations of the arches are given by Ogilby (*The Entertainment, etc., of Charles II*, fol. Lond. 1662). In the *Britannia Illustrata*, fol. Lond. 1714-20, pl. 45, is a view of Hempstead-Marshall. Excepting two printed essays, this was Gerbier's last production; for while it was building, he died there, in 1667, and was buried in the chancel of that church. The two publications are, in reality, but one work: the second portion, entitled "*Counsel and Advice to all Builders*", 12mo. Lond. 1663, has been so recently subjected to the attention of the profession, that it does not appear necessary to say more of it, than, except where it gives the prices of the materials, and of the workmanship of that time, it is inferior in interest to the following treatise, which is remarkable, not only for being one of the few early English publications on the art, but for being evidently the fruits of many conversations, held both with professional men and with amateurs, by one who himself understood the practice and theory of the art as an Architect, and at the same time, by a rare concurrence of events, was enabled, like Lord Burlington, by birth, education, and position, to comprehend the requisite points of buildings for the most refined courts of a luxurious age. The word "Builder", is applied by him to the building owner; and, in his use of the terms, Surveyor and Architect seem to be synonymous.

The promise of the reversion of Inigo Jones's post, mentioned in the following preface, does not seem to have been inconsiderately made; the arches and Hempstead-Marshall are *not* "horribly ugly", and may serve as very fair specimens of the taste of their day. In that view they are by no means discreditable in design, though not precisely ranking in purity of detail, with the best works of such classes of composition. With this reservation, then, those who wish to consult an account of the letters, productions, portraits, and other curious particulars of himself and his family, may refer to the *Anecdotes of Painting*, vol. ii, 8vo. Lond. 1826, pp. 114-126; but it is due to our author to note, that *George* d'Ouvilly therein mentioned, as a misprint for Gerbier d'Ouvilly, is the same as Captain *George* Gerbier d'Ouvilly, of the city of London, Esquire, "oltramamento detto Giorgio di San Giorgio di Vinegia"; and *Antoine* is also mentioned by the bibliopoles of France, where Balthazar published a work on Fortification. In the British Museum are copies of twenty-four of his works, published in England, several of which have passed through two editions.

John W. Papworth.

A Brief

DISCOURSE

Concerning the

THREE CHIEF PRINCIPLES

OF

MAGNIFICENT BUILDING;

viz. { *Solidity*, *Conveniency*, *and* *Ornament*. }

By *Sir Balthazar Gerbier D'Ouvilly*, Knight.

LONDON,

(*First*) Printed in the Year 1662 (*and again in* 1664).

TO THE KING'S MOST EXCELLENT MAJESTY.

May it please your Sacred Majesty,—

MY place of Master of the Ceremonies (which the King, your royal father, of blessed memory, confirmed unto me during my life, by the great seal of England), is to introduce foreign princes, or their public representatives, to your sacred presence. And in regard the place of Surveyor-General, was also intended to me (after the late Inigo Jones), I do make bold to introduce the three capital principles of good building to your Sacred Majesty, who hath seen more stately palaces and buildings than all your ancestors; and may be a pattern to all future posterity, by building of your own palace worthy yourself, and placing it, as the Italians, for their health, delight, and conveniency (as well as solidity and ornament), "La matina alli monti, la sera alli fonti," according to which, the main body of your royal palace may be set on the side of Saint James's park, and the gardens along the river.

If the book afford any thing worthy your Sacred Majesty's further satisfaction, I have obtained my end, and done the duty intended by, Your Sacred Majesty's

Most humble, most obedient, most loyal subject,
and most zealous servant,
BALTHAZAR GERBIER D'OUVILLY, Knight.

TO THE LORDS AND COMMONS ASSEMBLED IN PARLIAMENT.

May it please your Honours,—

IT being lately reported that your Honours have deliberated to have the streets made clean, to enlarge some of them, and to build a sumptuous gate at Temple Bar, I thought it my duty to present this small discourse of the three principles of good building; and, withal, a printed paper, concerning the cleaning of the streets, the levelling the valley at Fleet Bridge, with Fleet-street, and Cheapside; and the making of a sumptuous gate at Temple Bar, whereof a draught hath been presented to his Sacred Majesty, and is ready also to be produced to your Honours, upon command, with all the devotion of

Your Honours'
Most humble and most obedient servant,
B. GERBIER D'OUVILLY, Knight.

A BRIEF DISCOURSE CONCERNING THE THREE CHIEF PRINCIPLES OF MAGNIFICENT BUILDING: viz., SOLIDITY, CONVENIENCY, AND ORNAMENT.

WHEREAS building is much minded in these times, I thought fit to publish some principles thereon, which may stand the lovers of it in stead; yet without spending time and paper to note how a point, line, angle, demi-circle, cube, plinth, base, pedestal, column, head, architrave, frieze, cornice, or frontispiece must be made; and what dimensions all those several parts (a point excepted) must have, since all master-workmen ought to remember (as scholars their grammar, and arithmeticians their table) how every particle must have its just proportion; and that the height of windows and doors must be double their breadth; and, also, to be careful to maintain the due esteem of their art, since its dimensions and rules came directly from heaven, when the great Architect and Surveyor of heaven and earth prescribed the rules and particular orders for the building of a floating palace (Noah's ark), and the glorious, matchless temple of Solomon, the perfect house of prayer.

And, therefore, such precedents may serve to convince those who say, that a wise man never ought to put his finger into mortar, since there is a necessity for building, especially among nations who do not, or cannot, live in caves and hollow trees, or, as the wild Indians, who have no other roofs but of palmito-leaves; nor wainscot, but bamboos, as they call the poles to which they tie a woollen hammock to lie in.

There are three capital points to be observed by men who intend to build well; viz., Solidity, Conveniency, Ornament.

Those who have marshalled the orders of columns (to make good the first point), have ranged the Tuscan to be the supporter of a building; but such an atlas must stand on a firm ground, not as ill builders place columns (either of brick or stone), like things patched or glued against a wall, and, for the most part, against the second story of a building (contrary to the very Gothic custom, who, at least, did begin their buttresses from the

ground), as if their intent were, that the weight of the columns should draw down the wall on the heads of those that pass by.

Such builders confound the first and essential point of building (to wit, solidity,) with ornament and conveniency.

They will make a show of something, but miss thereby (as ill bowmen) the mark. They may, perchance, have heard of rare buildings, nay, seen the books of the Italian Architects, have the traditions of Vignola in their pockets, and have heard lectures on the art of architecture, which have laid before them the most necessary rules, as, also, the origin of the several orders of columns, and discourses made thereon; that the Tuscan is as the Hercules; so of the Ionic and Corinthian; the first of the two, to resemble the dressing of the daughters of Ionia, who had twists of hair on both sides of their cheeks. The Corinthian heads, to represent a basket with acanthus leaves, and the guttered columns, the plaits of daughters' and women's clothes.

That the Grecians (in remembrance of their victories) did range the columns in their buildings, to represent the number of slaves which they had taken; the grains, beads, drops, pendants, garlands, interlaced knots, fruitage, and an infinite number of ornaments which are put on the frieze, to signify the spoils which the victors had brought away from their enemies; and, to preserve the memory thereof, did place them on their buildings, that they might also serve for a true history.

But none of such ornaments were ever impediments to the strength or convenience of a building; for they were so handsomely and well contrived, as once the Duchess of Chevrëuse (a French lady) said of the English females, that they had a singular grace to set their ornaments right and handsomely.

The barbarians and naked Tapoyers, Caripowis, Alibis (and several Charibdiens) do place pendants in their nostrils, which are proper for their ears; and these hinder not the use of the lips, which ought to be observed by all builders.

As for the inside of fabrics, builders should, in the first place, set the doors, chimneys, and windows, as may be most convenient for use.

Builders ought to be not only experimented in housekeeping, but also good naturalists; to know (before they spend time and materials) the required property to every part of a building. A door to be so set, as it may not convey the wind toward the chimney or bedstead, though opened never so little.

The windows to be so placed, as that the fire made in the chimney may not attract the air and moisture, and so prove the unwholesomest part of the room for those that are near the fire; which was the main reason why the great Isabella, Infanta of Spain (King Philip the second's daughter, who governed the provinces of Brabant, Flanders, Artois, and Hainault, during her many years' residence at Brussells), being prepossessed with a prejudice, never approached a fire to warm herself; till at last, being throughly wet (going a procession in a great rain, and by a visit made by Mary of Medicis, Queen-Mother to Lewis XIII, just as she had returned to her palace had no time to shift her), she was constrained to approach the fire to dry herself, and a few days after, she fell sick and died upon it; which relation being very true, and happening in the time that I resided for the King of blessed memory in that court, I thought fit to mention, to persuade all noble and curious builders to place their doors, windows, and chimneys in their proper places.

And though it be not my design, in this small discourse, to treat of dimensions (which are fit for a primer to apprentices), yet I cannot desist (by reason of the West Indian hurricane-like winds which happened February last) to persuade all builders to forbear the building any more those exorbitant chimney-shafts, which, when they fall, break both roofs and ceilings of rooms, and kill good people in their beds; since a chimney some two feet higher than the ridges of the roof of a building (which is not overtopped by a church or steeple, or some other eminence), is as good a conveyance for the smoke, as any of a greater height. Neither are those high shafts of chimneys real ornaments to a building, much less to the palace of a sovereign; nor do the German travellers of this age, any more fill (as formerly) their table books with the number of them, as they were very careful to note the names of their hosts, where the best wine was, and when they tasted that called *lacryma Christi*, they moaned, and asked why He did not weep in their country. It is true, that the least addicted to bibbing, did put in their stam-books the dimensions of the Pantheon, and of the amphitheatres; as also of Caprarola, Frescati, and such magnificent structures above ground in Italy; and, under-ground, La Piscina Admirabile, La Grotta de la Sibilla Cumana, Bagni de Cicerone, Cente Camere, and le Sepulture de li nobili Antichi. But they are now taught by tutors to observe the inside of men and buildings. And as the best ornaments of a face, appear at first sight by the eyes, mouth, and nose; so do the best qualities of a perfect building, by windows, and doors well placed, as also by a large, magnificent, commodious, and well-set staircase.

Noble, magnificent, and commodious staircases, must in the first place participate of a nobleman's manner of pace and attendance.

There is no man of sound limb (and that hath a gallant gait), but lifts his toes at least four inches, when he goeth an ordinary easy pace; so that if two steps (each four inches high) be eighteen inches broad, or deep, which makes six-and-thirty inches the two, (the just measure of a man's two steps), they may be ascended, from the first floor, to the higher story, as if a man walked on a level ground.

Secondly. Those stairs ought to be so long, that the attendants on each side the noble person, prince or sovereign, may not be straitened for room.

Such were the monarch-like stairs of the Palace of Darius, and Cyrus the Great, at Chelminar, in Persia, near Saras, the metropolitan, between Ormus and Espahan. I do speak indeed, of a palace without comparison to any other; the walls of circumvallation of that palace, being four-and-twenty foot thick, and the stairs (as yet in *esse*), are forty foot long, in number a hundred and eight, of circular form, and of so easy an access, as that travellers do ascend them on horseback.

King James of blessed memory, could not have been so much in danger of an onset, in a pair of stairs large enough for a noble retinue to his person, as he was in a narrow pair, which history mentions.

Neither had William, Prince of Orange, been so easily shot, at Delft, in Holland, descending a narrow pair of stairs.

Thirdly. A noble pair of stairs should have a cupola, and no windows on the sides, which for the most part serve but for rude and unadvised men to break.

In some palaces and noblemen's houses, "Too many stairs and back-doors, (as the old English proverb) make thieves and whores." And the setting the front of a building towards the north-west, and a palace, like Cardinal Wolsey's ill-placed one, (now called Whitehall) on a low ground by the river-side, makes work for physicians, apothecaries, surgeons, coffin, and grave-makers.

But as for a seat on moorish grounds, except the builders observe the practice of those of Venice in Italy, and Amsterdam in Holland, who bestow more timber of oak, in the foundation of one, than in the building of six houses, in effect, it is to build perpetually, leaving to their posterity to prop and redress their ill-grounded buildings; and they may well be ranked with the Duke of Arscot, who built much in Brabant, and, (in a merry humour) designed in his will ten thousand gilders per annum, to support and alter what he had built amiss.

I must also advise builders on high grounds, to cause their Surveyors to search for springs, and shun them; which serve better to fill up glasses to allay the vapours of Gascony wines, than to make a pond in a cellar.

Builders ought also to be very curious and careful in the choice of the place to build a seat on, for good prospect, well garnished with woods, and the water at hand, not too near nor too far from a city, or town.

Item, I must wish all princes and noble persons, who are resolved to build palaces and seats answerable to their quality, to imitate those who in the heathen age were so careful in the ordering of the structure of their stone images, especially of their Saturn, Jupiter, Apollo, Mars, Neptune, and all their fry of wanton Goddesses, as to empanel a jury of philosophers, naturalists, physiognomists, and anatomists, who were to direct the sculptors how to represent those images. And so I would wish builders to proceed, in the contriving the models of their intended fabric, to wit, to consult (as those of Amsterdam did in the making the model of their town-house) divers experimental Architects, though they pitched, for the front, on the worst of all.

Item, before the workmen make use of materials, and not to build at random, as the custom of too many ill builders is; and when once the model is approved, never to alter, nor to pull down what has been well begun, nor to hearken to the diversity of opinions, which have been, and are the causes of many deformities and extravagancies in buildings; and especially those who seem to have had for models, bird-cages, to jump from one room into the other by steps and tressels, to cause men and women to stumble.

And the sides all of glass, like spectacles; the glass windows of small panes, with great store of lead, to draw the more wind and moisture, from the open air, within doors. As also windows with store of iron casements, which rust, and never shut close, notwithstanding all the various devices of smiths, to catch money out of the builders' purses, contrary to the good custom in Italy, Spain, France, Germany, and the Low Countries, which certainly for plurality of voices should be believed and followed.

Those nations cause their glass windows to be fitted in wooden casements treble riveted (rebated), to keep out wind and rain; they are lined with wooden shutters, and have double-boarded shutters without, to resist all the violence of the weather and thieves.

Let no man mistake these windows for wooden casements, for such [as] are usually seen here in England in old wooden houses, the casements scarcely above one foot and a half high, tottering things; for these are substantially, strongly, and curiously made casements; nor are the wooden shutters such paste-board like things, as are generally put on the outside of the windows, on the London and suburbs houses, but double-deal well-riveted windows, with substantial locks, bolts, and hinges, and a double iron bar, with a bolt fixed in the middle of them both.

Nor do good builders affect partitions of lime and hair in their houses, nor any of their bricks to be daubed over with finishing mortar.

The Romans are very curious in the tempering their mortar, and in the laying it as thin as possibly they can, to prevent the sinking and bending of their walls, which the laying of the mortar too thick does cause; and experience shews, that when some walls are taken down in England, half of the substance is sand and dust.

The Romans, as likewise the Grecians before them, did not make use of their lime at the same time it was slaked, but for six months time suffered to putrefy, and so putrefied composed a cement, which joined with stone, or brick, made an inseparable union, and such strong work, as I have seen iron tools break on the old mortar of the amphitheatres at Verona and Rome.

Their manner of preparing lime, is to lay it in cisterns, the one higher than the other, that the water (after it has been so stirred as that it is well mixed and thoroughly liquid) may drain from one cistern to the other; and, after six months time the lime (having evacuated its putrefaction), remains purified, and then they mix two parts of lime with one part of sand, and make that strong and pure mortar, which, if practised in England, would make a wondrous strong union, especially if the claymakers did beat the clay as it ought to be, the English clay being better than the Italian, nay, the best in the world.

They are very careful in the making large and deep foundations, and to let the walls raised on the foundations, rest and settle a good while, before they proceed to the second story.

Some of our carpenters have learned to lay boards loose for a time; the Italians, and other nations, are not sparing therein; they nail them, as if for good and all, but rip or take them up again, to fit them for the second time.

As I said before, no building is begun before a mature resolve on a complete finished model of the entire design. The builder, having made choice of his Surveyor, and committed to him all the care and guidance of the work, never changes on the various opinions of other men, for they are unlimited, because every man's conceits are answerable to their profession and particular occasion. A sovereign, or any other landlord, is then guided by natural principles, as well as by his own resolve, taken on a long-considered model, because they know, by experience, how sudden changes are able to cause monstrous effects.

They know that a well-experienced Surveyor must not be disturbed in his task and undertaking; but, as the silk-worm and the soul of man, the first in his husk, the second in the womb, wherein both the one and the other (by the powers of the great Architect and Director of all things) works out his own complete fabric, if not interrupted, but if interrupted by any outward accident, it happens that those passions become the original causes of exorbitant features and forms; an item for all builders to suffer a good Architect quietly to pursue his task, if he understand it.

It has been observed among the French (a nation as much addicted to changes as any), that, when the charge of an undertaking has been committed to many, it caused but confusion; and therefore it is a saying among them, "*Trop de cuisiniers gâtent le potage*," too many cooks spoil the broth.

I shall not spend time, and transgress on the reader's patience, concerning the making of clay, and burning of bricks, only say, that it imports much the clay should be well wrought before it is put in the mould. Experience has also taught brickmakers to have them of such a length, thickness, and wideness, that four of them (together with the mortar thereunto belonging) may raise a foot.

As for free-stone, Portland stone works well, and makes a good union with bricks, yet cannot be compared with marble, nor with the bluish stone of the quarries of Liège and Namur. But it is also certain that this climate makes marble itself to moulder very much; as, for example, the Cain and Abel in York House garden, which did not moulder when it stood in that of the duke of Lerma, at Valladolid, in Spain; the coldness, together with the moistness, of this clime being of a contrary operation to the temper of the air in Italy and Spain. And therefore, when builders see their copings, water-table, cornices, rails, and balusters, to decay, they must have patience, since there is no material but is subject thereunto; and that rails and balusters (either on the top of the walls of a frontispiece, or in balconies), though never so well painted in oil, and of the best-seasoned timber, but must be renewed at forty or fifty years' end.

Builders ought to calculate the charges of their designed building, and especially with what sum of money they are willing to part; and yet remember to imitate some philosophical humorist, who resolves to venture on a pretty thing called a handsome lady, without which their fate seems to tell them they cannot live; and therefore makes an account beforehand, that all things will not precisely answer his expectation. But, on the contrary, the lady, instead of being a good housewife, and an assistant, proves expensive, and an impediment. And if it prove otherwise, he will be a great gainer by the bargain; for let builders put their design to master-workmen by the great, or have it wrought by the day, either the workmen will overreach themselves, or the builder will be overreached.

Charity to the one, and respect to the other, moves me to keep the rest in my pen, yet shall never be backward to inform either of them, in the ear, what may be the best for them to choose.

But I must freely advise all builders in general, never to begin to build on a ground before it is purchased, as the late duke of Buckingham did at York House, where there has been much daubing and breaking through old, rotten, decayed walls; first, to make a ladies' closet on the corner of a wall where a buttress stood, and which was taken away for the closet, intended only at first for a closet of ease, and to serve until the archbishop of York could be persuaded to accept as good a seat as that was, in lieu of the same; which could not be so soon compassed, as the duke of Buckingham had occasion to make use of rooms, to entertain (according to the dignity of a prime minister of state) foreign princes and ambassadors: so as, on a sudden, all the buttresses that upheld that rotten wall were thrown down, the ceilings of rooms supported by iron bolts, balconies clapped up in the old wall, daubed over with finishing mortar, and all this (as a toad-stool grows in a night) to serve until a model for a solid building to stand even with the street were made, and to be built of such stone as the portico, or water-gate, at the river-side is; and this was done on a moorish ground, whereon no new building could stand any time without proppings, which was contrary to the main principle of good building.

I must proceed, and conclude, with my humble respects, concerning palaces of sovereign princes, which must differ as much from other buildings, as their quality and condition from that of their subjects.

And in the first place, as solidity must be the first principle in all good building, so much more ought it to be observed in that of sovereigns, unto whom the whole world has access.

And as there must be spacious ground before their palaces, their inner-court ample, the offices for their retinue large, and commodious, and so placed as they may neither be an annoyance, nor of ill aspect; the first stories ought rather to be vaulted than boarded, to prevent such an accident as happened to Louis XIII, French King and his Queen at a ball, when the floor of the room, with all the company, fell down; the King and Queen only remaining, (by a special Providence) on the hearth of the chimney, sitting under the cloth of state.

And as there is a necessary magnificence to be expressed on the front and inside of princely buildings, answerable to their greatness, so is it absolutely necessary that the Architect be possessed with a soul as great as the player in the French play called *The Visionaries*, where he persuades himself to be Alexander, and governs his motions accordingly. And the lines and strokes of the Architect must be Alexander-like:—his figures and statues, colossi; his pyramids like those of Egypt; and the vaults like that rock wherein Alexander and Darius wrestle for mastery, in a valley in Persia, between Babylon and Ispahan, at a place called Carimonshahan, where formerly was a great city, six English miles long; in which grotto, the Alexander-like mind of the sculptor hath hewn within the rock (besides Alexander on horseback, and a number of huntsmen and ladies) the aforesaid Alexander and Darius wrestling to break a ring between them.

Such a like mind Prince Thomas of Savoy (son to the great Emanuel of Savoy), infused into his Architect, sculptors, and caster in brass, whom he employed in the designing and building a stable, in Turin, within all of marble, the racks, manger, and the upright-posts all of copper, richly wrought, conveyances of water pipes. The manger fourteen inches wide at the bottom, to contain a pail of water on all occasions. The uppermost edge of the manger, three foot eight inches high from the ground, to accustom the Neapolitan great saddle-horses to raise their necks. The rack-poles three inches asunder, and upright, that as the Frenchman saith, *L'appétit vient en mangeant*, the horses may feed more cheerfully, the hay and dust may not fall on their heads, as it doth out of a rack which stands shelving: the under part of the manger ought to be made up, to keep in their litters, and no boxes made there for dogs, as some not curious do: where harnesses, saddles, coverings of horses, or any other implements or tools, are not to be seen about the postern, since those things do but impede the access of a cavalier to the horses.

The disposing a stable into a double range, has been affected by some, who would see all their horses at once.

Others love only a single range with a broad walk, and if they have a great number of horses, return at the end into another range, if the ground can afford the same, so as a wall makes the partition between the horses.

The paving of such a stable is very neat, being of white or yellow (twice burnt) Flanders bricks, in Dutch called *clinkart*, far beyond planking of stables, for divers reasons. The paviors (after the bricks are laid) throw sharp sand over them, and twice a day they are watered with a gardener's watering-pot, and swept with a broom, which the grooms are to continue sometime, because the sand gets between the joints, and makes the paving very close and firm. The pavement at the foot of the manger, must be raised at the least six inches higher, than at the gutter where the posts are placed, which ought to be five foot and a half distant one from the other, which ground so paved is of double use; first, that the higher a horse stands towards the manger, the better sight it is, and especially when the lights of the stable strike on the horses' backs, which is the better light.

Secondly:—That a horse's usual standing place being so much shelving, accustoms the horse (reposing more on his hinder feet than on the foremost), to be more light and nimble in his gait and pace.

Thirdly:—That his stale do not remain under him, and especially when his standing has eight foot in length from the manger to the channel, which for neatness ought to be above ground, the eight foot in length being at full the space which the horse possesses, when in the night time he lies stretched on his litter.

I must not omit, by way of queries, to write somewhat concerning the kitchen of a princely palace; viz.:—whether there should not be as much curiosity, if not more, in the kitchen than in the stable; since the meat prepared in a kitchen ought to be drest with all neatness, and preferred before a fine lace about the master cook's towel: neither are the vessels of silver but in reference to the neatness which ought to be observed in all cookery. The Frenchman's glass is wrenched [rinsed] as often as he drinks, and why should not cooks be more curious and neat in their kitchens, than grooms in their stables? And as a stable can have conveyances for the horses' water, so may kitchens for slabbering, for guts of fowls and deer, coals, ashes, and whatsoever else can cause dirt and nastiness, and be freed from the annoyance of smoke, which many ill-placed doors cause; nor ought the kitchen or other offices and cellarage, (as in some palaces in France), to be so placed as they may prove prejudicial to the Court; and if they are underneath a palace they ought to be vaulted.

I must not forget that the roof of a palace should be covered either with lead or blue slates.

The Pantheon at Rome was covered with brass, which a pope melted to cast cannons, not such (*canons*) as only eat, drink, and sing.

No curious eye can well endure those barn-like roofs of many noble persons' palaces, covered with red tiles, which break and rot away, and then the roof being mended and patched, seems to be a beggar's mantle, which I would not have the nobles' and courtiers' to be. See the roofs of Leicester, Newport, Southampton, and such like palaces, whether they do not look as barns for hay, and piebald, by their patched tiles?

As for the main bulk of palaces, it is true some have a greatness in plainness, as that of Farnese in Rome, whereof Michael Angelo made the architrave, frieze and cornice.

And, as for bigness and solidity, that of S. Hieronimo, and the Escurial in Spain; for ornament, that of Munich in Bavaria; the Louvre at Paris for vastness, situation, and ornament; by the embossed imagery on the frontispiece, variety of

orders of columns, with the delight of the annexed Tuilleries, wherein, as especially in that of the palace of the Duke of Orleans, but above all, in the Cardinal Vigna's in Rome, is observed the form of a true princely garden,—consisting not only in much air, great plots of grass, low borders, large gravel-walks, but for close walks, fountains, groves, and statues, to make good the Italian saying, *Per variar natura è bella.* And as for the embossed carved imagery on the frontispiece of a palace, their dimensions must be according unto their distance from the ground; which is a main point requisite to be observed also in schemes, wherein divers undertakers commit very great faults, not only by the not reducing whatsoever is represented, to the true lines of perspective, but also by omitting the giving such proportions to things, as may satisfy the sight of all the spectators at their several distances; for excellence does not consist in vastness, nor in the quantity of objects, nor shapes, nor colours.

The sphere in an angle of a great chamber in S. Pietro è Vaticano in Rome confirms this truth, and every judicious eye will be satisfied therewith. Seas must not only be seen to have a natural motion, but heard to make a noise of breaking of their waves on the shore and against the rocks. Clouds must not only drive, but be transparent. Winds, thunder, lightning, rain, snow, and hail, must be so heard, seen, and felt, as that spectators may think those sights to be natural operations. The sun, moon, and stars, no pasteboard devices; but so represented, as that they may dazzle the eyes of spectators. And all the motions of scenes and mutations as insensible, and no more to be discovered, than that of the hand of a dial.

Neither can all great rooms of princely palaces serve for this use, except they be after the model of such as the Italians have built; as there is a good one at Florence, in Italy, with conveyances for smoke, and capacities for echoes, which Inigo Jones (the late Surveyor) experimentally found at Whitehall, and by his built Banqueting-house; so as having found his own fault, he was constrained to build a wooden house over-thwart the court of Whitehall.

The greatness of a sovereign consists not in the quantity of stone and timber heaped together. The quarries possess more stone, and the woods more timber, than a banquet-room. Let any good eye judge, whether it be not true, that the extreme height of a room takes away the greatness of the company that is in the same, and that all hangings of tapestry make no show at all, unless they reach to a proportionable height of a room.

Since the greatness of a nation consists not in a husk, but in itself, and in its sovereign, nothing should be suffered to diminish the appearance of that greatness within or without doors. A sovereign and his retinue, in a too vast room in height, width, and length, appear like a company in a valley near high mountains. Whereas, a body standing on the brow of a hill, and seen from below, seems to be a kind of colossus; which argues that there must be a great discretion used, in the making them fit and pleasing.

All which I do not write to undervalue any modern works, nor any of the cavalier-like operas,—every good talent being commendable. As I am confident there are some that live, who will not deny that they have heard the King of blessed memory graciously pleased to avouch he had seen, in anno 1628 (close to the gate of York-house, in a room not above thirty-five feet square), as much as could be represented (as to scenes) in the great Banqueting-room of Whitehall; and that divers judicious persons will not deny, that the excellence of the several triumphal arches erected in the city of London, consists not in their bulk.

The Grecians and Romans (who have shewn their mastership in them) did conform them to the respective places.

Things can be too great, as well as too little; too massive, and too slender; too gaudy, and too plain; and colours placed together, which agree not one with the other, God, in his rainbow, having shewed us the best way of ordering colours. Nor is it the quantity of timber or stone that speaks love, in an arch; but, rather, when it is composed of the hearts of loyal subjects, which surpasses all that can be made.

May, therefore, the oldest and most tottering house in the land, breathe forth of its windows what may answer that true love; and in point of good building, wherewith this discourse is begun (next to the giving such a new form to the streets of London and the suburbs, as may in a manner equalize those in Holland in neatness, if the inhabitants will but take the right and only course therein), may his sacred Majesty, during his long prayed for and wished reign, see St. Paul's church in that magnificence, as the metropolitan of the houses of God in the chief city of Albion, justly requires; and his royal palace built, so as to answer the matchless greatness of him, whom all tongues of loyal subjects speak to be *Carolum Magnum Secundum, Dei gratia, Angliæ, Scotiæ, Franciæ, et Hiberniæ Regem, ecclesiæ, legum, et libertatis populi restoratorem*; which shall ever be the dutiful wishes of

Balthazar Gerbier D'Ouvilly, Knight.

EXTRACTS FROM THE

COUNSEL AND ADVICE TO ALL BUILDERS.

(*First*) Printed in the Year 1663 (*and again in* 1664).

From the Preface:—Furthermore, you may gather out of this treatise, a posie pleasing to your scent, and leave the gleanings, which are most proper to mechanics concerned therein, until a large work (with copper plates) shall have had time to be put forth; wherein, not only shall be represented in complete measure, the forms of all moldings, of orders, columns, ornaments for doors and windows, courts, houses, and garden gates; and withal some fronts and dimensions of houses, both in a city and in the country; churches, towers, houses, and steeples, with all necessary appurtenances thereunto belonging: as also the charges a builder may be at, according to the extent and height of a building, either made of stone, brick, or mixed.

Page 98:—Furthermore, in reference to the main contents of a former printed discourse, concerning the three first principles of magnificent building: as the well choosing of a fit place for a building is a capital point, to set it right, and the giving a fit extent to the court, so the making to it a porch ought to be well considered; for as a porch serves to a hall, to distribute alms to the poor; a porch proves often cumbersome, being the receptacle of foul creatures, who, as soon gotten into a court, make it their rendezvous. Nor is a porch so convenient to the palace of a prince, whose person must be attended by a great retinue, and no man to stand in his passage: but if a porch be affected, let it then be a vast portico, as that of Solomon's house, and that he built for Pharaoh's daughter.

Now, as for the placing a gate or door to enter into the hall of a palace; none will deny but that greatness and conveniency, being conjoined, fits best. The entrance into a hall is not so proper in the middle as at the end, when the ground plot is yet to choose and to be ordered: but if there be a constraint, which is most prejudicious to a building, the entrance must be set as much towards the end as possible can be, to set the chimney well, and the main staircase in so fit a place, as that it may not be subject to a like fatal accident, as happened to William, Prince of Orange, at Delft, when he was shot by one who stood behind a column, opposite to the stairs of that prince's house.

The rise, width, and depth of steps, shall not need to be repeated, since they have been described, and by reasons alledged for their dimension, mentioned both in the former printed and in this discourse; nor shall repetitions be necessary concerning the reason, why the first floor of a building should not lie level with the ground; the first for health; the second for neatness, since any floor level with the ground receives more dirt from abroad; the third for greatness, which appears more by an ascent; the fourth for the vaulting of cellars, or any other offices; and the fifth to have the floors more dry: only I shall insert this story of one in authority, who, passing by a town wherein the people generally did not outlive the thirtieth year of their age, caused all the back of their houses to be made the front, and the windows which were forward to be made up, to free them from that infectious air that did shorten their lives, which had its effects accordingly; and it is therefore I do so much insist on the point of placing a building where good air is, and that neither chimneys nor doors may be so placed as to serve for the attracting of infectious air, which kills more than the sword, or the seas overturn ships.

To take my leave of all builders, I must conclude with what followeth:—

First, that when they shall be pleased to take a posie out of the former printed discourse, and join it to what may please them out of this, they will find that both hit the main mark, to wit, solidity, conveniency, and ornament, altogether to be observed in true building; that all what is represented is for their profit and satisfaction; that the manner and phrase of the first discourse was to that end intermixed with recreative passages; that the reader should not be tired with the mechanics' phrases, and the proper names of their several trades, though some of them are wont to scoff at those whose language is polished, as if a person of eminent quality (born to the highest concernment of a state), should have learned their words, and have spent therein part of his precious time: and therefore I have now offered to write in such workmanlike terms, as may serve for a clerk of the works to speak unto them.

Secondly,—that all owners of buildings shall do well to make choice of such a person for their clerk as the master workmen will endure, which they will not, if he be a master workman, whom they will not only suspect to have a design to undermine and supplant them, but obey not, pretending to know more than themselves. Nor is it fit that there should be such a controller over a master workman, as a workman. The same is to be observed with a Surveyor, to prevent all quarrels and contests; for as every cook commends his own sauce, more than one cook to a dish will spoil it: there cannot be two suns in the firmament, one general over another, nay, two cocks among hens.

In a word, an owner must trust, or never make choice of trustees; for if otherwise, let him be certain that his purse will be incessantly abused.

Thirdly,—let all owners be prepared to repent, whether they build or not, for it is likewise the fate of many that marry or marry not.

Let both one and the other lay as in a scale, their several charges, vexations, cares, labours, and pleasures; they will find this to be true, viz. if they build, they must be at great present disbursements, vexed with as many oversights as printer setters will commit faults (as appears by the errata at the end of books), and to be overreached in bargains concerning their materials, as also in work done by the great or day.

If they build not, they are subject to the inconveniencies of houses built according unto the fancies of the owners, and when they shall cast up the sums of money spent in the rent (besides many chargeable alterations), they shall find that they might have built a better and more fit habitation: so will it be with men that marry or marry not. * * * *

Page 108: —Now of these two sorts of men, the one will resolve on the affirmative, and delight to spend money on choice materials, as in particular to imitate Solomon, in the procuring of precious wood; they may take notice (if they please) that store of precious wood can be had for the boarding of princely palaces, both for colour, aromatic smell, and durance; to make square framed panels (more rich than those which are seen at Paris in the cabinets of the palace called d'Orleans), which precious woods are to be had in several parts in the West Indies, some whereof are as red as the fairest vermilion, some yellow as gold, hard as marble; besides rare madeira, and others variously figured, as the right honourable the Lord Willoughby of Parham well knoweth what extent of land about Surinam (at Abacoa), is beset with speckled wood, and is not above six weeks sail from England, where ships full of lading may be had, besides large timber eighty feet high, straight, without a knot; and at no other cost but filling and lading, more advantageous than to pay for fur from Norway; besides a very gainful return of ambergris and vendible commodities, in exchange of iron tools, scissors, knives, old linen, and trifles.

To conclude. May all builders, both of palaces and of particular habitations, have good success, and possess them in peace and prosperity.

May also all Surveyors, master workmen, journeymen, and labourers, behave themselves so as they ought.

Take well this former counsel and advice; give no admittance to pride, the enemy of all learning; whereof a King was such a lover, as that when near the hour of his leaving the world, he saw one advance more than others within the curtain of his bed, he asked, "Whether he could learn him anything that was good?"

FINIS.

HEAT.

Heat, as required in architectural structures, results from raising the temperature of the air in an apartment, or suite of apartments, by means of various contrivances, so arranged as to take advantage of the laws which govern the transmission of heat.

It is unnecessary here to enter into a statement of the various theories promulgated regarding the nature of heat; a subject on which there is still very great diversity of opinion; but the principles which govern its movements, on whose due adaptation effective heating alone depends, must be briefly pointed out.

A body capable of affording heat, gives out caloric by two methods; these are radiation and conduction. Radiant heat is diffused through the air at an immense velocity, without materially raising its temperature, but immediately warming solid bodies exposed to its influence; its effect being increased in proportion to the number of points which a body presents to its influence: hence it is more rapid on rough surfaces than on smooth ones: the sun, fire, candles, gas, all give out radiant heat. In an apartment warmed by an open fire, the heat thrown out raises the temperature of the surrounding bodies, which, in turn, give out the acquired heat slowly. High temperature is required in bodies ere they can throw off much radiant heat; the redder the fire in an open fire-place, the warmer is the radiant heat; it follows then, that bodies at a low temperature, *i. e.*, below 212°, afford very little heat from radiation. Radiant heat is unequal in its effects; some parts of the body may be over-warmed by it, whilst others may be cold; moreover it can only be used on a small scale. If large fires be kept up to raise the temperature of a room, the heat near them is too great, diminishing as the square of the distance, to positive inefficacy. The attendant disadvantages of a number of fires are too obvious to be more particularly indicated.

When, therefore, the air of a large apartment is to be raised in temperature, the method of heating by contact is employed. The name sufficiently indicates the principle; for the volumes of air, coming in contact with the heated surface, become raised in temperature, are put in motion, and communicate the heat they receive to surrounding bodies.

The quantity of air, which may be warmed, will depend upon the area of heating surface; as only a certain volume of air can come in contact with a given space at one time. In order to obtain full advantage of heating surfaces, their area should be proportioned to the cubic feet of air required to be warmed; a small surface, if raised to a very great temperature, will heat a large quantity of air, if means are taken to pass it rapidly from contact with the heated surface: it is most advantageous, however, both on account of health, and economy of working, to have a large surface maintained at a mild temperature with a slow, but gradual, change of air. When the air comes in contact with a body greatly heated, it is rendered unhealthy by being deprived of its moisture, or being burnt as it is termed. In general if the temperature is above 212°, or that of boiling water, this effect is produced.

It will be seen that a movement of the air to be heated is an essential requisite in effective heating: in fact, a large body of air cannot be raised in temperature, unless its movements are assisted and sustained by ventilation. If air around a heated body be, in some measure, forced to be quiescent, only the portions immediately in contact with it are heated; air being a very bad absorbent, it only communicates or conveys heat when allowed to have free motion among the particles of surrounding volumes: a costly and complicated apparatus has proved totally ineffective, solely through want of efficient ventilation.

As the movement of heated air is upwards (Ventilation), it is obvious that the best place for the situation of the heating surface is near the floor of the apartment to be warmed, if possible beneath it. The air to be raised in temperature should have free access to it, and be allowed to flow freely upwards to the interior of the apartment. It is, therefore, manifestly erroneous to have, as is often the case, the heating surfaces, as steam, or hot-water pipes, hung within a few inches of the ceiling of the apartment. If the room be well ventilated, in which this plan is adopted, the warmed air will at once be passed from the apartment. If there be no means for ventilation, the parties occupying the room will be warmed only after a considerable lapse of time. The foregoing remarks being once thoroughly understood, there will be no difficulty in applying the various methods which are hereafter described.

In the present article will be mentioned, as concisely as the subject will admit, the various modes of heating generally adopted; by which advantage is taken of the principles already indicated—"radiation" and "conduction". These are, first, open fire-places, or Heating chiefly by radiation; secondly, high temperature stoves and furnaces, steam and hot-water pipes, or Heating chiefly by conduction or contact.

The most primitive mode of heating the air in apartments used by man was, in all probability, by consuming masses of wood, placed on the ground, in a central position of the room; the smoke being allowed to pass through the *entrance* aperture, or through one specially made in the roof. This is still the mode in use amongst the savage tribes of the American continent, and of other countries, and is even to be seen in the Highlands of Scotland; in many parts of Spain charcoal is burnt, in open braziers, in the rooms required to be warmed.

This mode of consuming the above species of fuel is of very ancient origin. In many of the religious ceremonies of the Greeks, the open brazier, filled with perfumed fuel, was generally employed; and, from using it thus, the transition to domestic purposes may have been sufficiently obvious to have induced the latter practice; for their apartments were warmed by burning fuel in like manner. Whether the method was anteriorly adopted for ceremonial purposes matters not, it is sufficient to know that it was the general practice for domestic convenience; the noxious fumes arising from the fuel being corrected, or at least disguised, by the addition of spices and perfumes. In Rome a similar system was in vogue; the receptacles for the fuel being, in some cases, of a costly and handsome construction. This antiquated mode of warming is not quite extinct; it has been employed for heating the entrance halls of places of amusement, and, in some cathedrals, it may still be seen in operation. A kindred usage, moreover, may be traced in the turf-hearth of too many of those dark, low-roofed hovels, remaining in the poorer districts of Scotland and Ireland.

In heating apartments, the Romans adopted another method, in addition to that described above; the principle of which has been adopted in the constructions of modern times. In this.

called the "hypocaustum", the rooms are heated by flues running under the floors, in some cases, supplied with heated air from a fire outside the building; in others the hypocaust was formed by a low chamber beneath the floor; the roof of which was supported by "small pillars, or by dwarf walls, and sometimes with flues leading from them to other apartments." (Tomlinson, *Rudimentary Treatise on Warming and Ventilating*, p. 53; Vitruvius; Adams, *Roman Antiquities*.) This plan, as above hinted, has been introduced in modern times, in hot-houses and other structures, and is largely practised by the Chinese.

Previous to the fourteenth century the apartments, even of the wealthy classes in Europe, were heated much in the same primitive manner. The fuel was burnt on an open hearth, in the centre of the apartment; the smoke, created by the combustion of the masses of wood which formed the fuel, escaped through an opening in the room, so arranged that while the smoke escaped, the wind and rain were prevented from entering. This contrivance, termed the "louvre", is still retained under the same name, in many structures of the style to which it is considered more especially to belong; the only mechanical aid to the combustion of the fuel, in such a mode of heating, being a horizontal bar, resting at either end on uprights, designated, as a whole, "andirons". The ends of the billets of wood placed on this, being raised from off the hearth, the circulation of the air, beneath and around them, promoted vivacity of combustion: for the manipulation of the wood, a large two-pronged fork was used.

On the introduction of chimneys (Chimneys), the next obvious improvement took place; the fire, instead of being on the hearth in the centre of the hall, was removed to a recess wall of the apartment. The andirons were, however, still retained; and these, in the halls of rich families, were handsomely constructed; the standards, in some instances, being of silver. The recess, or receptacle in which the hearth was placed, was usually of large dimensions; seats being formed around it, on which the inmates reclined, enjoying the heat and comfort of the cheerful blaze.

The transition from the andirons to the grate, or "cradell", as it was long called, was the next alteration. The large recess, or rather apartment above described, was only eligible in capacious halls; so that when smaller chambers began to be heated, it was much diminished in size. The andirons were then fixed into the back by bars; and, in some cases, these were removeable at pleasure; in this arrangement the horizontal billet bar represented the front bars, and the sides of the recess, the jambs, or covings of the modern grate.

The improvement following this was, probably, the bending of a few bars into a semicircular, or rectangular form, and the ends fastened into, and supported by, the back wall of the recess. In the chambers once occupied by Mary, Queen of Scots, in the palace of Holyrood, in Edinburgh, may still be seen an old grate, or cradell, somewhat in this style; and which, according to tradition, was first introduced into Scotland by that princess. Tomlinson mentions (p. 64), that, in an inventory, dated 1603, of the goods of Sir Thomas Kyston, of Hengrave Hall, Suffolk, there is mention made of "a cradell of iron for the chimnye, to burne sea-coal with."

So long as wood was plentiful as a fuel, coal was rarely used; indeed, on its first introduction it had to contend with deep-seated popular prejudices, and judicial penalties, enforced by government against those, who attempted to use it: but on the construction of fire-places being improved, so that the smoke was carried off from the apartment with some degree of certainty, the advantages of coal were soon appreciated.

Early in the seventeenth century, Savot succeeded in effecting decided improvements in the construction of fire-places. The principal defect complained of in the grates placed in small chambers, was, that a door, or window, had to be left open to supply the fuel with air; or the consequence was, that the smoke was driven into the apartment by the air descending the chimney to the fuel. Savot's mode of obviating this difficulty was, by lowering the mantel, raising the hearth, and constructing the width between the jambs, so that the orifice of the fire-place was left three feet square. From this period till the early part of the eighteenth century, little attention appears to have been paid to the subject.

About the year 1713 a book was published in France with the name attached of Guager; who, according to Tomlinson, (*Rud. Treat. on W. and V.*, p. 70), was the celebrated Cardinal Polignac. The cardinal, however eminent the position he attained in his more peculiar walk, shewed that he fully understood the principles upon which effective heating was to be obtained by the open fire-place. The value of the book (some of the details of which will be hereafter given) may be known from the fact, that almost all who have, since that time, given their attention to the subject, have helped themselves liberally to his ideas, without being, in many cases, equally eager to acknowledge the source of their information. The celebrated Desaguliers translated the cardinal's work, and published it in London in 1716, under the title of "Fires Improved, or a New Method of Building Chimneys, so as to prevent their Smoking; in which a small fire shall warm a large room, much better than a large one made the common way. And the method of altering such chimneys as are already built, so that they shall perform the same effects. Second edition, 1736, with an appendix, containing several further improvements, made by the translator and others."

Notwithstanding the admirable hints thrown out in this work (to which the reader, curious in this matter, is referred); the practical hints of Dr. Franklin, given ninety-five years ago; those of Count Rumford, published some years later; and the many valuable suggestions of scientific men of the present century, it is matter of surprise that so many defectively constructed fire-places should still be in daily use. In treating of this part of the subject it is thought best to notice, in detail, the principles on which grates ought to be constructed.

The history of the introduction of the open grate has been already glanced at. In many mansions, and first-class houses, specimens of this mode of heating are to be met with, in which it is difficult to say whether the beauty of design, or elegance of finish, is more noticeable than the excellent arrangements, adopted to secure the full heating effect of the fuel consumed. In these the principles of effective heating are carried fully out; so far, of course, as the peculiarities of the system are capable of improvement. This state of matters, unfortunately the exception not the rule, has been brought about solely by the devotion of their talents by savans to the subject, and by the careful attention which professional men now pay to such matters.

In the fire-places of modern apartments in this country, grates are almost universally used. The object in all such being to heat the lower portion of the hearth and surrounding substances, the bars should be placed very low. The consequence of this arrangement is, that the floor and hearth being warmed, the cold air, which flows into the apartment in contact with them, is warmed by the ascending currents of heated particles. There should be provision made for admitting fresh air to the front of the fire bars, not beneath them; as radiation is chiefly required from the front, the fuel there will be more quickly consumed by the fresh air thus thrown against it. Another beneficial advantage derived from the use of this contrivance, or "blower", as it is called, is, that the currents of air along the floor, found in all apartments not having this plan, are dismissed. In Fig. 1, shewing the arrangement, the grate is indicated by *a*, the air-flue entrance at *b*, the position of the egress aperture, or blower, at *c*.

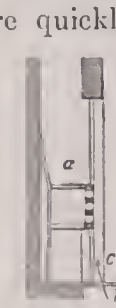


Fig. 1.

The materials of which the bodies of grates are generally made militate very much against economy in their use; the desideratum is to have the fire surrounded by non-conducting materials. Iron should be sparingly used in parts near the fuel,

and never allowed to surround the place in which it is actually consumed. Some manufacturers content themselves with leaving an aperture at the back of the grate, on casting it, to be afterwards filled in with fire-brick: this is an approximation to what should be the law, yet it is not carried out to its fullest extent: the sides also should be filled in with fire-brick. A form of grate in which the fuel is carefully surrounded on the sides and back, by good non-conducting material, is that known as the "fire-lump grate": such non-conducting bodies could be easily applied to any size of grate, by taking a model of its interior

Fig. 2.

with a piece of block-tin. Fig. 2 is a plan of this body, having the sides at a proper angle at the back. In some grates, where the internal dimensions are too large, malleable iron sides, or "cheeks", are used to lessen the space, and save the fuel; the above non-conducting body might for this purpose be substituted with advantage. As before mentioned, the chief effect derived from grates, as generally used, is from "radiation". It is, then, of importance to construct them so as to have as large a surface, of burning coal, as possible presented to the interior of the apartment to be warmed. This will be best attained by making the breadth and depth of the front as large as convenient; while the breadth, from front to back, should be of the least dimensions, consistent with the space requisite for steady combustion. A good proportion was found, where the breadth, from side to side of the front bars of the grate was fourteen inches, the depth, from the top to the bottom bars was ten inches, and the width, from the inside of the top bar to the back of the grate, was six, but at the bottom, four inches. (GRATES.)

In order that the rays of heat may be readily and surely sent into the room, the sides, or covings, should be made at a certain angle, or curve to the back. The form in which the sides are at right angles to the back, is the one worst calculated to throw out the rays of heat: GUAGER demonstrated very clearly the disadvantages of this form. "Supposing", says he at page 4, "the fire F *f*, Fig. 3, in a common chimney, whose sides, or jambs A B; *b a* are parallel to each other, the ray of heat, *f g*, will be reflected to *m*, the ray of *f h* upon itself into *f*, the ray *f k* into *n*, and the ray *f l* into *p*; and as the ray *f l*, going from *f* to *l*, constantly rises, as it does also when, after reflection, it goes from *l* to *p*, it must get within the flue before it reaches *p*; and then, whenever it strikes against the fore part of the funnel which is inclined to the horizon, it will be reflected upwards into the chimney; always supposing the angle of incidence to be equal to that of reflection; and therefore it cannot go into the room. He next demonstrates the effect of having sides with a parabolic curve. "Geometry teaches us that all rays which, coming from the focus of a parabolic curve, strike upon its sides, after reflection, go on parallel to the axis. If, therefore, on the back part of the hearth of the chimney A B *b a*, Fig. 4, the length C *c*, be taken equal to the length of the wood to be burnt, as for example 22 inches; and from the points C *c*, the perpendiculars C D, *c d*, be drawn for the axis of two half parabolas, whose vertices shall be at C and *c*; and the distance of the breadth of the chimney be two points of the said parabolas, then if those parabolic jambs A C *c a*, be covered with plate-iron, brass, or copper, and the under part of the chimney-piece be made parallel to the horizon, and as broad as may be, leaving only 10 or 12 inches for the passage into the funnel: this chimney will not only reflect a great deal more heat than common chimneys, but as much heat as any chimney *possibly can do*. For if F *f* be the two foci of the half parabolas, when the billets, whose length is supposed F *f*, are on fire, the rays of heat darted from the said foci F *f*, which in common chimneys cannot go into the room, and so are useless, will here be reflected parallel to the axis *c d* to *m n o p*, and consequently go into the room. If the rays, which come from any part of the fire between the foci of the parabolas, be examined, it will appear that though they are not reflected from the jambs in such a manner as to go on parallel to the axes C D *c d*, yet they will all be reflected into the room as G H I." (Page 7.)

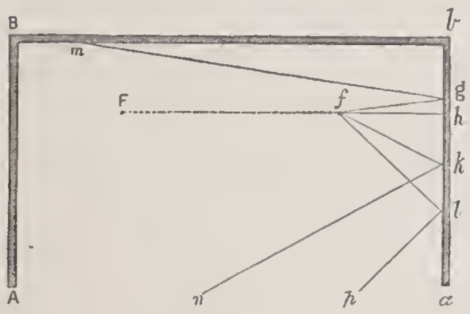


Fig. 3.

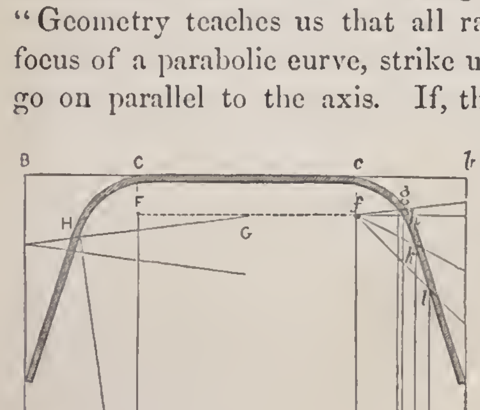


Fig. 4.

In some cases it may be deemed desirable to improve old-fashioned grates; this may be done by bending round, and placing in the inside of the jambs, plates of metal in the form of a parabola. As the curve is somewhat difficult to describe, it has been found that nearly equal advantages are to be obtained by having the sides, as drawn in Fig. 2, at an angle of 135° to the back. Count Rumford was the first to introduce this form.

The material of which the covings should be made is of importance. Absorption of heat is the point to be avoided, reflection that to be promoted. Iron absorbs heat rapidly when rough, and radiates little, or nothing, when below the temperature of red heat. Non-conducting materials, as brick, mortar, earthenware, absorb radiant heat very slowly. The nature of the surface of the material employed exercises an important influence on its reflecting powers: polished surfaces absorb little heat, but reflect powerfully; white surfaces reflect better than black, and if rough, less than when smooth. To meet these implied conditions, earthenware, with polished light coloured surfaces, will be the best material to be employed: it will be as perfect a covering as can be obtained, and may be looked upon as the standard of efficiency. The colour may be cream, pale blue, or green; but the nearer it approaches to white the better. To prevent all obstruction of radiation from the burning fuel, the bars should be made as light as consistent with the required strength; and all heavy ornaments thereon should be carefully avoided.

The proportion of the front of the grate to the size of the room, TREDGOLD (*The Principles of Warming, etc.*, § 177, 8°., Lond., 1836) gives as follows: "if the length of the front of the grate be made one inch, for each foot in length of the room; and the depth of the front be half-an-inch, for each foot in breadth of the room, the proportions will be found near the truth in the cases usually occurring in practice. If the length of the room be such as requires the grate to be longer than two and a half feet, two fire places will be necessary; and in that case the same proportions may be adopted, divided into two grates: unless the room be very wide, when a greater length should be given, and less depth, so as to preserve an equivalent area."

Grates should not be placed too far in, under the mantel-tree; the outside bars may be flush with the outside of it. The practice of making the recesses for the reception of grates deeper than absolutely necessary, should be at once condemned. The form of grates almost invariably used, is that known as the "register", or similar construction. These, when placed in their receptacles, leave a large empty space between the back and the wall; this often having direct communication with the flue above, serves the purpose of a deposit for all falling soot, which accumulates until it reaches that part of the back of the grate which is apt to be—in fact, is generally—highly heated, and combustion ensues. It may be objected, that the backs of grates are, in some cases, made of fire-brick; and that, consequently, the heat is not sufficient to cause ignition. Admitting the fact, the inference may be denied: it takes a much lower degree of heat to ignite so combustible a matter as soot, than is generally supposed; and the result of all experience proves that this is the case. Again, sparks may be carried up the chimney, and fall down amongst the soot; but all objections to an unlimited condemnation of the practice of leaving spaces behind grates,

are but poor and lame excuses for not getting rid of the absurdity. The use of a flue is to carry off the created soot, and that of a fire-place to heat the room; it is, therefore, as unphilosophical in principle, as inducive of danger in practice, to allow spaces to be left for the reception of that which has no right to be there; or to construct grates in such a manner as to make it a *possibility* that inflammable substances near them may be ignited.

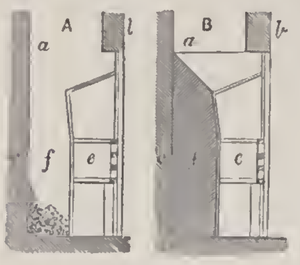


Fig. 5.

Fig. 5 will illustrate the proper form of construction of the recess which should be provided in apartments, for the placing of the grates: A shows the method too much in general use for old chimneys; *c*, the back wall; *b*, the wall of the apartment; *e*, the grate; *f*, the receptacle behind, having free communication with the flue *a*. B shews the plan recommended; *c*, is the back wall; *e*, the grate, closely placed in contact with the brickwork *f*, the shape of which should be that of the back of the grate. Iron chimney-bars, or bearers, ought always to be used in preference to those of wood; for one of the great desiderata to be attained in the construction of fire-places, is the complete isolation of all the parts from the rest of the materials composing the edifice; and it need hardly be said, that the farther all wood-work, whether plastered over or not, is from the grate or flue, the better. All the joints should be carefully cemented; and, if double brick-work be employed, the joints should break one with another.

The chimney vent, at its lower end, should communicate with the fire-place only, so that descending soot must of necessity fall into the grate. At the place where the flue commences, immediately above the grate, a valve opening upwards should be placed; this may be made of sheet iron, hinged at one side, similar to the register of improved grates. If a similar valve be placed near the exit-aperture of the flue, in the event of the soot therein igniting, the fire may almost instantly be extinguished by shutting it, as also the lower one; thence no air gaining admittance, combustion will soon cease to act. Should it be inconvenient to place this upper valve in or outside the roof, it may be opened and shut by a rod passing down the flue, and continued, for a short distance, in the interior of the grate; an aperture being made in the dome or top of the grate to admit of its passage.

Before describing plans for the economical arrangements of grates, so as to derive full advantage from the fuel consumed, it will be necessary to point out, very briefly, the forms in which the heat generated by combustion exists, and then to see how it is communicated to those bodies which are warmed. The heat generated by the fuel exists under two forms, "combined" and "radiant". The radiant heat, as already shown, is influential in raising the temperature of bodies only when it is stopped or absorbed by them; it never raises the temperature of the air through which it passes. Combined heat is communicated to bodies by actual contact. The radiant heat from the fuel in the grate depends, for its efficiency, upon the surface of red, clear, burning fuel in the front, towards the room. The combined heat goes off, in the form of smoke and heated air, to the atmosphere.

A point of considerable importance has often been mooted in this way: "What proportion does the radiant heat bear to the combined, produced in a grate as commonly constructed?" Though this point has not been determined with any considerable degree of precision, it is, however, quite certain that the quantity of heat which goes off, combined with the smoke, vapour, and heated air, is much more considerable—perhaps three or four times greater, at least—than that which is sent off from the fire in rays; and yet, small as is the quantity of this radiant heat, it is the only part of the warmth generated in the combustion of the fuel burnt in an open fire-place, which is ever employed, or which ever can be employed, in heating a room." (RUMFORD, *Essays*.)

In attempting to derive the utmost advantage from the fuel consumed in an open fire-place, the plan generally adopted has been, to pass air in contact with the back and sides of the grate, which, being heated, raised the temperature of the air. GUAGER, in 1713, was the first to describe a very simple and effective plan of heating air by means of a fire-place; and Fig. 6 will amply illustrate the *rationale* of his plan. A chamber was made at the back of the grate or fire-place, provided with a conduit made by a series of flat metal plates, somewhat shorter than the height of the chamber; these were placed at short distances from one another, but commencing from top and bottom alternately.

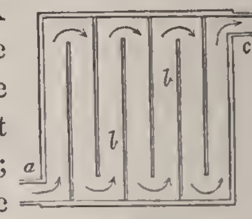


Fig. 6.

This arrangement left openings in such a manner, that the air was obliged to take a zigzag or circuitous route, so that it occupied a considerable time in passing through the whole extent of the chamber. *a* is the air-flue leading from the external atmosphere to the interior of the chamber; *b b*, the flat metal plates; *c*, the tube leading the air to a grating placed at the side of the chimney-piece, communicating with the interior of the apartment. The arrows shew the direction of the atmosphere when being heated.

Instead of leading the air to the apartment in which the fire-place is situated, it may be taken to the one above.

The mode by which the heated air was admitted in any desired proportion, was as follows. Two cylinders were procured, one revolving within the other; the external one having a handle, by which it was moved, passing through the cover of the outer cylinder. In the external cylinder three apertures were cut, and in the internal two. "To fix this double cylinder (Fig. 7), the opening *m n* being placed opposite to the way of warm air from the cavities, let *d p* be opposite to the passage from the cold air, and *l g* open toward the chamber. Now when *q y* is over against *d p*, only the warm air will go into the room; but if *b c* be turned over against *m n*, nothing but cold air will come into the room, for the hole, *m n*, through which the warm air came, will be stopped; but if the part *c* were only brought forward to the middle of the hole *m n*, half of *d p* would be open; then warm and cold air would go into the cylinder, which would be mixed as they came out through the hole *g l*; if but a third part of *n m* be shut, only a third part of *d p* will be opened." (GUAGER'S *Fires Improved*, p. 106.)

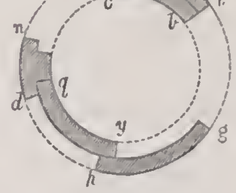


Fig. 7.

The principle of taking advantage of the heating surface at the back of grates, has been applied to the warming of extra rooms in labourers' cottages with considerable success. The following (Fig. 8) is a sketch of the plan given in the *Report of the Sanitary Condition of the Labouring Population of Great Britain*. *a* is the cold air pipe, *b b* the heating chamber at the back of the grate, *c c* the pipe leading to the rooms above, *d d* the grating, having apertures in the upper side for the admission of the heated air, *f f* the chimney-flue, *g* the grate. An improvement on this arrangement would be effected by making the warm air pass up the pipe in close contact with the flue,—in fact, one side to form the side of the chimney; thus, full advantage would be taken of the smoke and heated air. There would then be no division, as in the shaded part of the figure. The part *e* of the hot-air chamber in the extra room should be thinner than that at the back of the grate: indeed, the only thing to apprehend in this construction, is the overheating of the air through the thinness of the back of the grate; slabs of earthenware, one inch thick, would answer better.

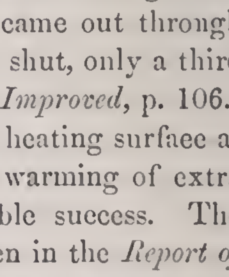


Fig. 8.

The cold-air flue in this, and the blower in the other, arrangements shown, should be provided with valves. A method of regulating the supply was thus adopted by GUAGER (p. 108). A small frame was fitted in the hole or aperture made in the

hearth-stone; the edge of this frame not being rebated, but bevelled downwards, so as to prevent the ashes from lying in the frame and preventing the valve from being shut closely down. To this frame a little trap-door was hinged at the side furthest from the fire, and which could be opened by means of a button; the under side of the trap had fixed at each side two sector-shaped pieces of iron; these directed the air, when the trap was open, to the front of the flame; two small springs at each end pressed upon the sectors, and kept the trap open at any desired angle.

To give a list of the names of various grates which have been introduced from time to time, and to point out their peculiarities, would occupy more space than their intrinsic merits deserve. Numerous as have been their forms, the principle has been very nearly the same in all of them; the alterations, or alleged improvements, consisting more in the manner in which the fuel was consumed or applied, than in the alteration or improvement of the heating surfaces. There have been, nevertheless, a few arrangements by which the radiation of the heat into the room has been materially assisted by the admirable arrangement of the parts; those of Sylvester and Joyce deserve especial notice, for as radiant heat is assuredly the most healthy and agreeable, any plan by which the radiation from a common fire-place can be increased, must be a boon of some value to the community.

To these may be added Cundy's patent fire-place, as a grate which is very effective in this respect, from the excellent arrangement of the heating surfaces; Mr. Cundy having wisely discarded all metal and iron as generally used, save for the external ornamentation; in place of it he allows the flame and heated air to pass over, and in contact with, masses of Stourbridge clay; a material which rarely attains a heat sufficient to burn the fresh air suffered to come in contact with it. The fresh air to be heated passes, along a flue or flues, connected with the external air, into the hot air chambers formed by the clay, and afterward into the apartment. By an excellent arrangement of the clay surfaces, their full heating effect can be obtained in the manner of a well arranged stove, yet the cheerfulness of the open fire-place is still retained. The fresh air gaining admittance from the exterior to the place beneath the fire bars, the fuel is so well supplied with the air necessary for combustion, that, with a well constructed chimney, no fear of smoke entering the room need be apprehended. Upon the whole, this stove, or fire-place, appears to rank as the most efficient, and certainly the most economical, yet introduced. It has all the advantages of Cardinal Polignac's fire-place, with none of the disadvantages attendant upon the materials employed by him for his heating surfaces; and when used in a well ventilated apartment, it has been found to give satisfaction.

The inhabitants of this country have an insuperable objection to close stoves, and perhaps justly so; the cheerfulness of an open fire-place being admitted on all hands. "The light, also, is not to be considered a mere nominal advantage, but a real and positive benefit, affecting the whole system by its physical action, independently of the cheerful impression which its liveliness is calculated to excite, and which, to many, is so engaging, that they feel as if they were not alone when they have the company of a glowing fire. These considerations will probably always sustain the open fire-place in countries where fuel can be procured with sufficient economy" (Reid; *Illustrations of Ventilation*, p. 130). But open fire-places, pleasant as they undoubtedly are, are by no means calculated to give satisfaction in so far as the economical consumption of the fuel is concerned; they are creative of much dust, and require constant attendance; it is of importance, therefore, that attempts should be made to improve the construction of the grate, so as to obtain the full effect of the fuel consumed. It is believed that a close attention to the principles herein described and explained, will prove that this is not such a matter of difficulty as is generally supposed.

The second division of this subject, Heating by high temperature Stoves and Furnaces, now comes under consideration. The varieties of stoves are numerous; but the principle upon which they depend for their efficiency is in all cases nearly the same. This may be stated to be the heating of plates of metal, or other quick conducting material, by the combustion of fuel in actual contact therewith; or by the impingement thereon of products of combustion, heated to a high temperature. In the majority of stoves, the air to be warmed, passing over these highly heated surfaces, is burnt, or deprived of its inherent moisture. In some, however, the fuel is so judiciously consumed, that the material confining it is rarely heated to an unhealthy degree: this, however, is the exception. In the following remarks, a brief description will be given of the stoves generally in use; more particularly illustrating those which in principle seem best adapted for creating and maintaining a healthy heat, in the apartments in which they may be placed.

The most simply constructed stove, and that which is much used, is shown in Fig. 9:—*e e* is the body of the stove; *d* is the door by which fuel is admitted; *b*, the pipe or funnel for leading off the products of combustion. The great disadvantage attending this form is, that the air to be heated, by coming in contact with the highly heated external surface, is certain to be burnt. This, it is evident, from the nature of the construction, cannot be controlled with any degree of certainty; and the only mode of restoring the grateful humidity of the air is by placing a bason of cold water on the top of the stove, the vapour from which relieves the dryness. This contrivance should be looked upon as a mere expedient to overcome an evil which ought not, and need not, be tolerated, if proper advantage be taken of the laws regulating the creation and maintenance of heat. One advantage is certainly possessed by this stove, that its whole exterior is an extensive heating surface: the conducting power of iron, of which it is generally made, being great, the temperature of every part is raised very considerably, whether affected by the actual juxta-position of the fuel or not.

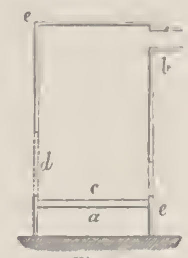


Fig. 9.

The heating surface can be materially increased, and the full effect of the heated products from the fuel obtained, by lengthening the smoke tube, and retaining this in the room in which the stove is placed: there is a limit, however, to this; as by increasing the length, the draught will be lessened in a corresponding degree. There is no loss of warm air (as in the common fire-place, where much effective heat is carried up the chimney); the air required for combustion being forced to pass up through the lower grating of the stove. The stove thus described, better known as the "cabin stove", although most generally met with, may be considered as the most unhealthy, and faulty form of construction which can be adopted, besides being very dangerous; as the flue and body of the stove, from becoming over-heated, often set fire to surrounding materials.

The most obvious improvement in this form is by surrounding the fuel with a non-conducting substance, and by causing the heated products to pass through a series of passages before allowing them finally to escape; so that the heat may thus be communicated to as extensive a surface as possible. The following arrangement is, in some degree, more satisfactory; the mode of leading the products is similar to that adopted in the Russian and Swedish stoves, to which, in fact, it has much resemblance. *e e*, in Fig. 10, is the body of the stove, made of cast iron; *a* the grating on which the fuel is placed; *c c* a fire-lump casing, placed in the inside of the stove surrounding the burning fuel; *d d d* a series of plates, so placed in the interior that the opening is left at each alternate end; through these openings the smoke and heated products pass, finally issuing through the flue *b*. The Russian stove is generally placed clear of the walls, so that all the surface is used effectively; in some cases it is placed in an aperture communicating with two apartments, thus heating them both. There is no grate in these stoves; the

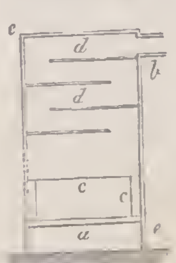


Fig. 10.

bottom, on which the fuel rests, being solid; wood being generally burnt, after lively ignition has ceased, and the portions completely burnt, the red embers are raked together, when, the door of the stove being firmly shut, and the aperture of the chimney being closed, the heat given out is found to last for a long time. To have the full effect of these stoves, the heated air produced is not allowed to be carried off by ventilation. The products of respiration, etc., are frozen on the windows: when a thaw ensues, the cake of ice melts, and the deleterious gases evolved often produce vertigo and fainting, in those inhabiting the apartment.

The effective heating of a common stove (Fig. 9) may be increased by lengthening the funnel. Tomlinson (*Rud. Treat. on Warm. and Vent.*, page 105) thus describes the effects of elbows, or bends, on the smoke tubes, as first elucidated by Mr. Bull. It "appears that the same length of pipe is much more efficacious, when it has elbows, in imparting heat to a room, than when it is straight; that a descending current may be somewhat more efficacious than an ascending one, but is about equal with a horizontal one; and that a horizontal pipe, with the same number of elbows, is more efficacious, in imparting heat, than when placed vertically for an ascending, or descending current. The cause of the increased effect is supposed to arise from the shape of the pipe forcing the air to make abrupt turns; in doing which, it impinges against the elbows with sufficient force to invert its internal arrangement, by which a new stratum of hot air, from the interior of the current, is brought more frequently in contact with the sides of the pipe, and particularly with the lower half of the horizontal pipe, which, from various causes, gives out very little heat to the room without the aid of elbow joints. But the advantage gained by increasing the length of pipe, and number of joints, has a limit very far short of that which is found to be necessary to impart all, or the greatest part, of the heat generated, to the air of the room. Only five parts of heat in one hundred were lost by using thirteen and a half feet of pipe, consisting of nine elbow joints; whereas eight additional elbow joints, and sixteen and a half feet additional of straight pipe, in all twenty-eight and a half feet of pipe, were required to save these five parts, and prevent them from flowing into the chimney. By diminishing the diameter of the pipe, the heating effect is increased, partly from the retardation of the current, and partly from the small pipe exposing a greater surface to the air, with the same quantity of smoke, than a pipe of larger diameter."

This plan of making elbow joints, or tubes, will be found only eligible where coke, or charcoal, is consumed: the soot from coal would accumulate so fast, at the turns, as soon to clog up the orifice, and lessen the draught. A tube three inches in diameter, attached to a small stove in constant use, has been found so completely filled up with soot in the course of a week, that a stick, half an inch in diameter, could scarcely be passed through the hole left in the centre.

Cleaning these pipes is always an ungrateful task for servants; of course it is frequently neglected, and often, when a stove is required to act to the most advantage, it will not work at all: it is therefore a question whether stoves, less economical in fuel, would not be found more satisfactory in operation.

Passing over the vast variety of stoves which have been brought forward as new, or perfect in their arrangements, but all of which depend upon the principles herein elucidated, that form which, more than any other, has attracted general attention will now be described: this is known by the name of its inventor, as "Arnott's stove". The principle on which this stove depends for its efficiency is the burning of the fuel very slowly, and the detention of the heat in the stove. The mode on which this principle is carried out, varies in almost every form of the stove which has been brought out; and not in all cases has it been closely attended to.

Generally a large outer case is made of iron, and lined with fire-brick, or clay; the fuel being consumed in a grating placed at the bottom, or in a fire-box within the outer casing. The products of combustion are carried off by a tube, after being made to circulate in the interior casing by means of a partition, disposed as seen in Fig. 11; where $a\ a$ is the outer casing, b the fire-box containing the fuel, $c\ c$ an internal partition dividing the casing into two chambers, communicating at top and bottom, d the tube by which the products of combustion are carried off. The door for admitting fuel is quite air-tight; and the aperture, for admitting air to the ash-pit, is capable of being shut and opened according to the temperature of the air in the interior of the stove. The apparatus by which this is effected is as simple as it is ingenious: although the forms, in which it is to be found, are various, the principle in all is the same. A very simple one is selected, which will sufficiently indicate the principle, and mode of operation. In Fig. 12, $a\ a$ is part of the stove, bb a pipe supplying the air to the ash-pit, $c\ c$ a tube having its upper end in the interior of the stove, and its bent extremity on the outside; when the temperature in the interior exceeds the limit required, the mercury, which is in the tube $c\ c$, expands, and is forced up in the part d; thereby closing up the aperture of the pipe $b\ b$, according to the degree of expansion. The quantity of air admitted to the fuel is only sufficient to maintain combustion, so that the air passing off by the chimney is of small amount.

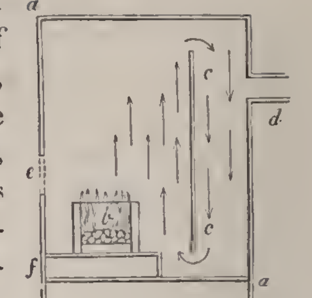


Fig. 11.

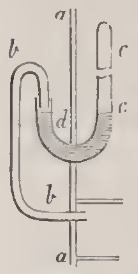


Fig. 12.

The partition, dividing the chamber into two, is the cause of a constant circulation being kept up, which soon causes the air in the interior to be somewhat uniformly heated. The effect which this partition thus has may be easily understood. The portion of air behind the partition, farthest from the fire, must of necessity be cooler than that in the front chamber; as there is no direct influence of the fuel in it, and the heat is withdrawn from the sides of the stove, forming its side and back. The air in the first chamber being heated, rises, and communicating with that in the second, is diffused therein, and deprived of its heat through the sides and back of the stove; being cooled, it descends, and, passing along the aperture at the bottom of the partition, is again heated by the fire, and ascends; so that there is a constant circulation of air maintained in the stove. The amount of air withdrawn by the tube d, Fig. 11, bears but a small proportion to that in the chamber.

It should be remembered that this stove is not adapted for maintaining ventilation: the circulation of air being of such trifling amount, that it will be necessary, in order to prevent the close and stifling atmosphere otherwise felt, to have proper arrangements made, by which the vitiated air may be withdrawn: this will, of course, necessitate the increase of heating power to make up for the heat thus withdrawn. From the slow combustion of the fuel, carbonic oxide of gas is generated; this has been tested, by placing a vessel containing a solution of subacetate of lead, in which insoluble carbonate of lead was produced. By increasing the rapidity of the combustion this effect may be obviated; but all such changes are departures from the original principle.

Stoves are sometimes fitted up with descending flues; the period of the introduction of this form is of early date. An artist of the name of Delesmus invented in Paris, in the year 1686, a stove of this kind, in which the smoke descended, and was consumed. Justelein afterwards described it as follows, in the "Philosophical Transactions", (See *Journal des Sçavans*, 1686, page 116). In Fig. 13 "$a\ b\ c\ d$ is a hollow cylinder, made of plates of iron, open at both ends, within whose inferior base $b\ d$ there is fitted the grate $b\ d$: this cylinder, which is the fire-place of the instrument, is joined to the cylindric tube $e\ f\ g$, in such a manner that there is a free

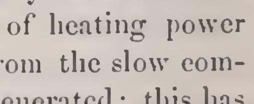


Fig. 13.

communication between their cavities. This tube *e f g*, is of the same capacity with *a b c d*; made of the same metal, and, in the same manner, is open at *g*, and close at *e*. If then the tube *e f g* be made very hot, and some live coals are laid on the grate *b d*, and over them some combustible matter, then the flame that is produced will descend into the tube *e f*, and pass through *f g*, and all the heat will go out at *g*; and the smoke likewise that is generated following the same course, through the pipe *e f g*, will be forced to pass through the flame that fills the whole tube; and hence, being acted upon by the fire in all this passage, it will lose the thickness and disposition of smoke, will be converted into flame, and in this form, passing out of the aperture *g*, will disappear without any visible smoke or soot."

Dr. Benjamin Franklin was the first who improved upon this plan; and produced his vase stove, with descending flue. Fig. 14 is an elevation of this form. The top *d* of the stove is moveable, and through this the fuel is admitted; it is provided with a hollow knob, perforated with holes, through which the air descends to the interior to support combustion; a grating is placed near the middle of the vase at *c*, and another at the bottom of the hollow base *b*; the pedestal *a* is also hollow, and provided with a series of plates, forming a zig-zag passage leading to the flue. There is no communication between the flue and the room, excepting by the opening in the lid of the vase. The vase and hollow pedestal are placed in a niche in the ordinary fire-place, so that the heat produced is sent directly into the room. The plan, Fig. 15, will illustrate the position of the passages in the hollow pedestal *a*; *b b* is the pedestal; *a a* the grating at the bottom of the space *b* of the preceding figure; the smoke and flame, passing through this grating, goes towards the back of the chimney as at *c e*; then, dividing into two streams, one goes round the partition marked *d* out to the chimney flue at *h*, while the other stream turns round *f*, out to the flue at *h*. The air, in passing, gives out its heat to the pedestal, and is thus communicated to the room. A box, or drawer, is inserted between the partitions *c* and *e*, below the grating *a a*, into which the ashes drop.

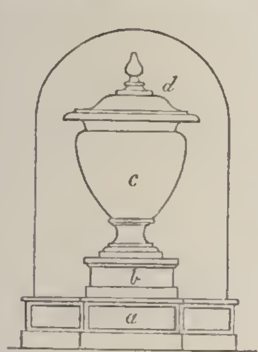


Fig. 14.

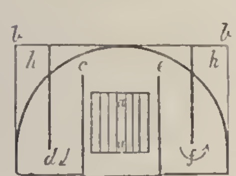


Fig. 15.

This excellent contrivance would be much improved if the vase was lined with fire-brick; this would tend to prevent the air being desiccated by the overheating of the part in which the fuel is consumed.

One advantage obtained by this form of stove is, that the smoke from the coals being consumed, by passing through the burning fuel, the chimney flue will thus be kept comparatively clean; the only smoke passing through it being when the fuel is first kindled. By this consumption of the smoke the greatest advantage is taken of the fuel; the particles of soot, passing off in the generality of fires, being but portions of unconsumed fuel. The air in a common fire-place rising, as soon as it is heated, in great quantities uselessly up the chimney, much of the heating power of the fuel is lost; but in this stove, being made to pass downwards, and in contact with a large heating surface, the greater portion of the evolved heat is made useful. This form of stove may be used with advantage in heating an office, or basement apartment, where the floor is paved, for the following reasons:—the best mode of fixing it will be to dispense with the pedestal and enclosed partitions, and to allow the heated air, from the vase, to communicate with a horizontal flue, running beneath the pavement of the floor; this may be led in any direction required, and should finally communicate with an upright shaft, or chimney.

The horizontal flue may be made square, the paving stones forming the roof of it; or circular earthenware tubes may be adopted; these being placed in excavations rather larger than the diameter of the tubes. In the former case, the heat will be communicated to the room by the floor; in the latter, the air, surrounding the circular tubes being heated, must be admitted to the apartment above through grated apertures made in the floor. To have the full effect of this plan, the excavations in which the tubes are placed should be freely supplied with air.

A somewhat similar arrangement is mentioned by Tomlinson as having been eminently successful; the heat obtained being kept up at an annual cost of 30*s.*, while by another apparatus the cost was £18. (*Rud. Treat.*, page 108.)

It should be remembered that an essential requisite, in the construction of descending flue stoves, is a chimney with a good draught. With this adjunct, Franklin's stove will be found exceedingly economical. Another advantage, not generally known, to be obtained from its use, is the economization of the fuel; from its conservation, while in a red state, by the flame surrounding it. The conserving power of flame is familiarly illustrated by observing the wick of a candle when allowed to burn a considerable time; if completely surrounded by flame, the reddened portion will remain unchanged for a long time, but if moved from the influence of the flame, it is instantly consumed, and passes away. Franklin, while noticing this among other advantages possessed by his stove, cites the above illustration of the principle (*Philosophical and Miscellaneous Papers*, page 74). His attention was first drawn to the circumstance, from having watched, through a small opening, in the side of one of his stoves, a piece of red coal, which he expected to see pass away consumed by the heat, remain for a long period without diminishing in bulk. As the flame to be kept up will require a continual supply of fuel, the conservation of the fuel is not carried out to its fullest extent, where flame is not continually passing downwards; nevertheless, Dr. Franklin found the stove very effectual in delaying the consumption of the fuel.

When descending stoves are adopted, care should be taken to instruct the parties attending them in the right way of kindling them. As an upward current is generally established in chimneys in the morning and evening, these will be easiest kindled before eight in the morning (Chimneys), and after eight in the evening. In kindling descending flue stoves, the current must first be ascertained; if drawn steadily downwards, the stove may be lighted without danger of the smoke being drawn into the room; the coke, or coal, should be placed first on the grating, then sticks, and paper; the paper being lighted, it will ignite the sticks, and then the coals. By having a damper, or valve, placed at the top, where the air is introduced into the stove, the draught may be lessened, or increased, at pleasure.

Smoke, from all fire-places, stoves, and furnaces, having a considerable portion of heat contained in it, it becomes a matter of some importance to obtain contrivances by which this heat may be advantageously used. In the preceding remarks it has been shewn how the heat of the smoke can be made use of in common fire-places (see Fig. 6); and in some of the stoves which have been described, arrangements for this purpose are also indicated. Thus in the Franklin stove the smoke is made useful in giving out heat, and also when the horizontal flue is adopted. In describing the common stove, Fig. 9, it has been shewn that, by lengthening the smoke tube, the heat therefrom may be made available. This plan cannot, however, always be carried out; for, in the generality of cases, the length of tube will be cumbersome.

A mode of obtaining the fullest advantage of length of tube, with but little space, may be gathered from the following description: suppose the back of the stove to have a casing attached to it, the smoke tube finding access to it at one side near the top, and the casing to be provided with passages made with partitions, the openings of which will be at the top and bottom alternately, as in Fig. 6; these passages being covered with an external casing of thin iron, the smoke having to pass in a zigzag direction, gives out its heat thereto. The casing should be easily removable, to clean the passages, when required, from the accumulated soot. The winding passages may be made of

circular earthenware tubes; if these be placed behind the stove, having perforations at top and bottom, the fresh air will ascend to the casing, pass in contact with the pipes, and issue heated into the room through the apertures above. This last arrangement will be more practically available when coke or charcoal is burnt in the stove, as the tubing will not be liable to be choked with soot: if the inside of the tubes be glazed, this will not happen so frequently, even when coal is used.

In hot-air pipe stoves, the gaseous products of combustion are led through a series of pipes to the chimney, the air to be heated passing in contact with the outer surface of the pipes; the form above described is therefore a stove of this description. The porcelain stove, another form of hot-air pipe stove, is highly recommended by REID for producing "a mild, genial, and equal temperature" (*Illustrations of Ventilation*, p. 239). Fig. 16 is an internal elevation of this form; where *b* is the body of the stove, with the flue *c c c* circulating as shewn: the whole internal case and piping is covered with an external casing, provided with apertures near the top and bottom, to allow the air to enter and pass out when heated.

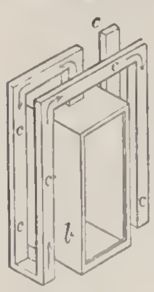


Fig. 16.

The employment of Gas as a heating medium for stoves has long been suggested; but from the defective construction of the contrivances adopted, much prejudice was raised against their use, and their general introduction greatly retarded. As an economical heating power, attention has of late been so strongly directed to it, that it may be expected shortly to be seen largely employed in structures, both private and public. The gas stove originally introduced consisted of a gas jet, or series of gas jets, burning in the inside of a metal casing, the air to be heated passing in contact therewith.

The principal feature in these stoves was, that the products of combustion being considered so harmless, or at least unworthy of notice, when compared with smoke, no chimney was deemed necessary. Now herein lay the great objection to these; for independently of the deleterious nature of the fumes evolved, the offensive smell occasioned by the gas (which is peculiar to gas stoves alone) was enough to exclude them from general use. In many of the forms more recently introduced this erroneous plan of allowing the products of combustion to pass into the room to be heated is still followed out. It is conceived that so long as this is continued, so long will gas stoves be considered, and justly so, as unhealthy, and will be hindered from being used. If the products of combustion be taken away at once, the stove will then become as healthy as any in use; and if due care be taken that the surfaces, which the flame heats, are so small that it cannot create a temperature sufficient to burn the air, then it will be not only healthy, but the most economical form which can be used.

A good form of gas stove would be the arrangement of a circular pipe, punctured with small holes, in an internal casing; if this be covered with a second casing, leaving a space between the two, the air may be admitted between them, and passed into the room by apertures at the top of the stove. The products of combustion being of comparatively small volume, the tube to lead them away need not be of large diameter. A gas heating stove may be made with advantage on the principle of the "Arnott" stove. It is believed that this would be economical, and be productive of satisfactory results.

The true method, however, of having healthy heat from gas, is by placing a double cylindrical vessel containing water, round a series of gas jets; by which, the water being heated, will give out a grateful heat from its external casing. An idea of the economical nature of this mode of heating may be obtained from the fact, that forty-five gallons of water can be heated to a temperature of one hundred and six degrees Fahrenheit, from sixty-two degrees, in the space of six minutes; at an expense of one penny; calculating the gas to cost six shillings per one thousand cubic feet.

The result thus obtained is by the patent process recently introduced by Mr. Defries. His plan is simple: a series of flat tubular pipes, communicate with the water in the vessel to be heated; copper pipes are placed along the whole length of these, perforated with holes, so that several hundreds of gas jets are thus made; the water flows into these tubes, and, being heated by the gas, ascends, and the cold water takes its place; this goes on till the whole water is heated. It is evident, that by a judicious placing of the gas jets, a large surface of pipe or tubing may be supplied with hot water, at a very moderate cost.

A very ingenious gas heating apparatus has recently been introduced by Mr. D. O. Edwards: it is termed the "Atmopyre". The following is the inventor's description of it:—"'Hoods' of tobacco-pipe-clay are made, perforated with numerous holes, the fiftieth of an inch in diameter; below these, gas is introduced; mixing with the air, it forms a species of artificial fire-damp; this being ignited on the outside, burns with a pale blue flame, and soon raises the hoods to a red heat. A number of them are placed beneath an earthenware casing, the aggregate heat of the hoods raising this to a red heat. The hoods consume, when thus heated, five-sixths of a cubic foot per hour, and eight of them are calculated to warm a room containing four thousand cubic feet."

The fitness of the "atmopyre" to secure a perfect ventilation is thus exemplified by the inventor:—"A battery of twelve 'hoods' is inclosed in an earthenware case, which becoming heated to four or five hundred degrees Fahrenheit, constitutes a repository of heat. This is placed in an outer case of china, terra-cotta, common ware, or any other non-refracting substance. The products of combustion are carried away by a small pipe entering the chimney. The fresh air is brought from outside the house, through a large pipe, about six inches diameter, which communicates, by means of a valvular iron plate, with the space contained between the two cases. The air ascends in this area in large quantities, is warmed in its transient contact with the inner case, enters the room, through large holes in the top of the stove, at *one hundred and twenty degrees* of Fahrenheit, and diffuses itself equally through the apartment; maintaining such a temperature as the inmates may desire. The fire may be concentrated in one part of a room, or distributed over the several sides. The strictest economy would require that the 'chimney' or 'way out' for the products of combustion, should be in alto-relievo, within the apartment, in order that the least possible heat should be lost".

By a judicious arrangement of the outer casings, it is possible that a healthy heat may be obtained from this invention; which certainly recognizes the principle above advocated, namely, the carrying away of the products of combustion from the apartment. Without attention to this feature, no satisfaction will ever be obtained.

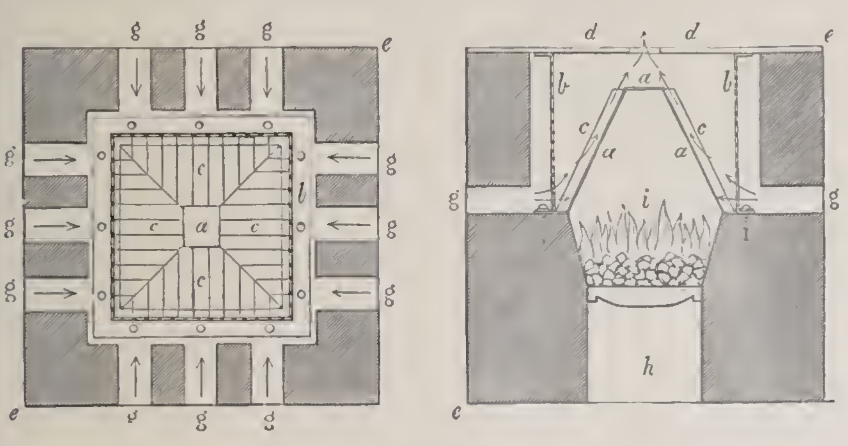
High temperature furnaces have now to be considered, or the forms of apparatus used for warming large spaces. Their leading feature may be stated to be, plates of metal, or surfaces of brick or stone, heated in or by a furnace or fire; the air to be warmed being caused to impinge upon, or pass between, them. It is evident that, from the nature of the process, the air cannot be regulated in temperature, and is liable to be over-heated; nevertheless, by great care, and an adaptation of the various parts of the machinery one to another, air may be effectively and healthily warmed.

This is exactly the principle which Mr. Strutt, of Derby, endeavoured to carry out; Fig. 17 is an elevation of the form of cokel adopted by him. *a* is the internal fire-place; the smoke and gaseous products from the fire leave by the chimney, *c*; the internal casing, *b b*, is made of brick-work; an external case, *d d*, is placed over this, so as to leave a space, up

Fig. 17.

which the air can pass, as shown by the arrows, into the flue *e*. The fire heats the brick casing, which, in its turn, communicates the temperature to the air passing up the space. This is known as the "Strutt" or "Belper" stove (so called from the name of Mr. Strutt's seat in Derbyshire).

The principle of Sylvester's stove, is similar to that of Strutt's cokel; in fact, it is merely an improvement thereon. A cast-iron cone or cokel is placed above a fire-place or furnace; the air to be heated is projected through pipes made in an exterior casing, covering the cokel. In some cases this casing is made of brick-work: in the improved plans iron is used. The improved construction of this stove is shown in Fig. 18, where



A Fig 18. B

A is a plan, and B a section, of the stove; *e e*, the fire-place; *i*, the fire; the chimney flue is at the back part of the furnace; *a*, the cokel; iron ribs, *c c c*, are placed in the manner shown in the drawing, so as literally to compel the air entering through the flues or fresh air openings, *g g*, to pass upon the heated surface of the cokel, it having been found that a flame held at the ribs was extinguished by the draught; the air thus heated passes upwards into the chamber *b* above, from whence it is led by flues through the plate *d d*, to the place to be warmed. This form of stove seems well adapted for economical heating; and by properly regulating the temperature of the heating surface, a healthy degree of warmth may be obtained.

There is one feature in connexion with it worth mentioning, viz., the facility with which cold air can be admitted to the building to which it is attached, in summer as well as winter. The change of temperature effected in a crowded or heated church, for instance, in summer time, is greater than would at first sight be supposed. At the Derby Infirmary, the cold air flue was four yards square, and seventy long. In the month of August, the temperature in the shade being 80°, the air which entered the stove room was 60°, and the velocity of the current was such as to blow out a candle.

In applying this stove in original constructions, a fire-proof chamber must be built expressly for it; this is, in fact, the cause which precludes its trial in buildings already constructed, and not similarly provided. There are, however, many churches, etc., having subterranean chambers, in which highly defective heating apparatuses are used, wherein the stove now under consideration might be placed with advantage.

The size of the fire chamber must obviously be so regulated, that the iron dome shall never exceed a certain temperature; 300° degrees was the limit assigned to it by Mr. Sylvester.

"In theory, Mr. Strutt's cokel is a simple and elegant application of principles to obtain the whole effect of the fuel; and in less skilful hands must have failed entirely, as far as regards economy; but in practice, it requires a building to be provided for it; otherwise it is a cumbrous mass, which it is difficult to find a place for, and still more so to give a tolerable appearance to the parts which ought to be ornamental as well as useful."—Tredgold, *Principles of Warming, etc.*, § 8.

Where a large quantity of air is to be heated, and consequently a large heating surface is required, the cokel will, from its size, be very awkward; if of very great diameter, as the fuel will be much spread in the interior, it will not be so effective; consequently additional vertical height must be given to it.

In its place may be adopted the plan of constructing a longitudinal furnace, similar to that of a steam-engine fire-place, placing, round the brick case, a series of square flues, one side of which should be formed by the furnace casing: these flues should run along the whole length of the furnace, and communicate with a chamber, the opening of which should be at its highest part; at this, the flue leading to the place to be warmed should be attached. In Fig. 19, *a a* is the front of the furnace, *b* the ash-pit, *c* the pipe leading to the apartment above. The entrances to the pipes are shown by the shaded squares.

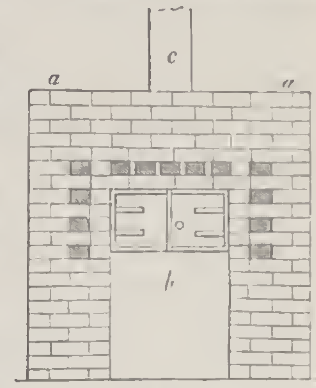


Fig. 19.

A furnace might also be constructed with an arched top; a series of earthenware, or thick iron pipes, might run along within a few inches thereof, protected from the effects of the direct flame by a partly spherical shield, made of cast-iron, stretching below them. The fronts of the tubes are to be open for the admission of fresh air, the other ends to communicate with a chamber leading to the apartment to be warmed.

Another form of furnace for heating large quantities of air, known by the name of the Hot Air Pipe Furnace, is shown at

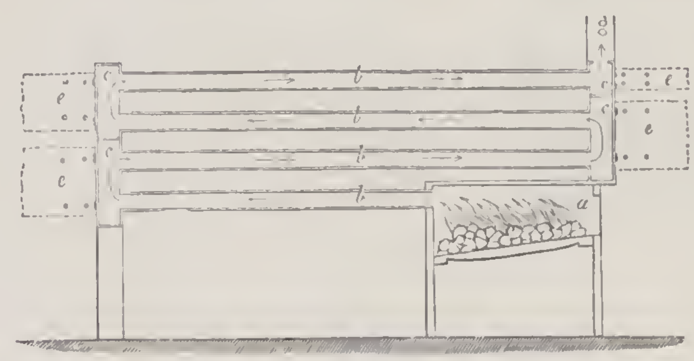


Fig. 20.

Fig 20; where *a* is the fire-place, with sloping bars; the heated air and smoke pass through the pipes *b b*, communicating with the chambers *c c c c*, and finally issuing into the flue *g*. The pipes being thus heated, give out their heat to the air which passes up through, and between, the pipes, and is led to the apartment to be warmed by means of flues; or by grated apertures in the floor of the apartment, if the furnace room be situated directly beneath it: doors *e e e e* are made to open into chambers *c c*, so that the interior of the pipes may be cleaned from their contained soot when required. In this form of stove the full effect of the fuel is obtained, the smoke being made useful.

In all these forms of apparatus, where a large separate chamber is required for them, the apartments above might be ventilated, by bringing the air, by means of channels, to supply the furnace. (Ventilation.) In constructing the flue by which the air is led to the apartments to be heated, care should be taken to have the interior carefully covered with fire-proof cement; and, above all, not to allow beams to pass through, or indeed to come in contact with them. The circular stone-ware tubing might be used with advantage.

The common form of grating may be placed at the apertures for admitting the hot air to the interior of the apartment.

The interiors of the cokels and furnaces above described should be made of fire-brick, carefully cemented with fire-clay, or fire-proof cement; if more than one thickness be used, the joints of the last laid series should not coincide with those of the first, but should "break joint". This is necessary, as the heat opens the joints, even in the best made furnaces; and the gaseous products, escaping, become exceedingly noxious.

Common bricks should never be used for the interiors of furnaces, as they ordinarily emit, even at a low temperature, a disagreeable sulphureous vapour, causing a most offensive odour. The outer joints should be well pugged with blue stiff clay till

within half an inch of the surface, then finished with a layer of good consistent mortar; this treatment, if the furnaces be not very much overheated, will prevent the emission of noxious fumes.

In too many cases the heating surfaces of cokels are made of iron; this ought not to be done, as it is certain to create overheated air, and they are, moreover, inducive of danger. It is not too much to say, that almost all the public buildings consumed by fire owe their destruction to the defective apparatus employed to heat them. Parties fitting up such contrivances forget, or are not aware of the fact, that a *not very high* temperature is sufficient to ignite dry wood-work: and too frequently the parts are so defectively constructed that flame and smoke have egress into the flue. Wherever iron is used in hot air furnaces a lining of fire-brick should always be provided; the grand desideratum, in all such heating appliances, being to keep the temperature of such heating surface nearly to 212°, and never higher than 250°.

A process has been recently patented by Messrs. Davison and Symington in which the heated currents of air are used for drying purposes in various branches of manufactures; and which, under certain circumstances, is applicable to the heating of apartments, with a degree of precision and capability of control, seemingly highly advantageous. The principle may be seen from the following diagram, Fig. 21.

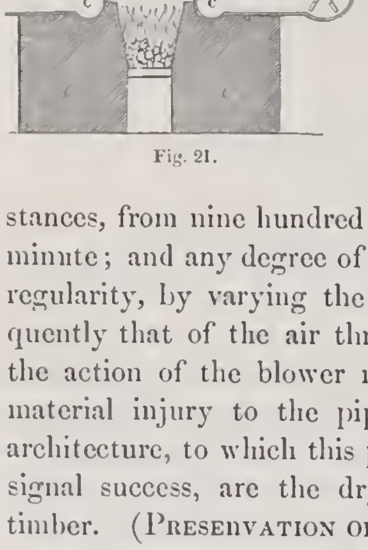


Fig. 21.

A series of bent pipes *c c c* are placed over a furnace fire *a*; the flame and heated air of which, coming in contact with the pipes, heats them to a high degree of temperature: the air to be heated is driven in and through these pipes by the fanner *d*. The velocity of these fans varies, according to circumstances, from nine hundred to thirteen hundred revolutions per minute; and any degree of heat can be kept up with the utmost regularity, by varying the velocity of the fanners, and consequently that of the air through the pipes. Any cessation of the action of the blower may be expected, however, to cause material injury to the pipes. The processes connected with architecture, to which this plan has been applied with the most signal success, are the drying of wood, and preservation of timber. (PRESERVATION OF TIMBER.)

As power is required in all cases to work the fanners, when a steam-engine is used in a building for ventilation, or other purposes, this form of heating apparatus may be used with advantage. Care in this case will be requisite to produce the requisite degree of heat; this is done by regulating the intensity of the fires, and the velocity of the fanners: the air, even when of a high temperature, being remarkably pleasant; this, of course, is to be attributed to the speed with which it passes over the heated surfaces. (VENTILATION.) Thus in a drying house for silk, when, by means of hot iron cokels, the temperature of the room was raised to 120°, the air was close, stifling, and oppressive: when the air was thrown in at the rate of seven thousand cubic feet per minute by the fanners, through small perforated iron plates in the floor, the sensation, on entering, was agreeable and pleasant; the temperature being the same. The great advantage obtained by the use of this process, is the speed with which the temperature of the apartment can be raised and lowered, by the properly regulated, yet constant, working of the fanners.

In all these contrivances, save in the last, a limited quantity of air only can be heated; as the surface would increase in proportion to the cubic contents of the place to be warmed: for a large space, a huge ungainly size would speedily be obtained; this would involve expense in construction, as well as in maintaining the fire. By stoves placed in the interior of a very large apartment, partial benefit only is obtained; the space near them being overheated, the places further off scarcely feeling the influence. It is almost impossible to heat a church, for instance, equably by means of one stove, however large, placed in the interior, on a level with the floor.

The economical working of cokels, furnaces, and stoves, is of very great importance, not only as regards saving of expense, but the maintenance of a steady warmth: yet, unfortunately, little attention is paid to it. The plan generally adopted is that, a few hours before the building is to be occupied, the stove, or furnace, is lighted, and a huge fire is maintained with the view of "getting the heat up quickly"; the heat is frequently so intense as to crack the brick, or iron work, greatly endangering the building. The best mode is to keep up a gentle heat, for at least one full day before the building (if large) is required, and to maintain the fire at a low rate of combustion: the heating surfaces will then be gradually warmed, and the joints of the casing escape uninjured.

Another point too often neglected, is the supply of the flues with fresh air to be heated. In general it is considered quite enough if the fire-place is supplied; in too many cases this has not been attended to, and the flues may draw their supply of air as they best can. It should be remembered that the sole aim and end of all these contrivances is to heat the air; if this air be not supplied in sufficient quantities, it is clear that the heating power must be expended uselessly. Upon examining a heating furnace which was totally ineffective in warming the church to which it was attached, it was found placed in an apartment below the level of the floor; there was a fire calculated to raise easily as much steam as would have heated every part of an apartment three times the dimension of the church, in half an hour, or at the most an hour's time. This stove was generally kept up at this ruinous rate of expenditure for twelve or fourteen hours, sometimes in very cold weather for twenty-four hours; and, after all, the church was by no means comfortably heated when the congregation assembled. The mode of construction was as follows: above the arched top of the fire-place a large chamber was made, used to warm the air; the entrance to this, for admitting the air, was immediately above the door of the fire-place: from each side of the chamber a flue branched off, leading to a space made in the passage, and covered with a grating. The upward current was found scarcely strong enough to lift, very perceptibly, a silk handkerchief placed on the upper side of the grating; at the other, the handkerchief, instead of being raised, was pulled downwards; shewing the existence of a current down the flue instead of up, as it ought to have been. On descending to the heating chamber, the door of the hot air chamber was found shut; so that the air had to be drawn from one side of the church to be heated, and then passed into it at the other. The attendant had no very clear ideas as to the use of the door opening to the hot air chamber; all that he seemed to think necessary was the keeping up of a large fire. Now in this case, the type of too many others, had a full knowledge of the principles and constructive details of the apparatus been given, this result could never have existed. This has been pointed out as the cause of inefficiency in many arrangements, as well as explanatory of a simple means of experimenting on currents and movements of heated air.

The next method of heating large spaces by contact, is the use of steam as a means of giving heat to reservoirs, whose surface can never exceed the temperature of boiling water, unless the steam be created under a very high pressure; which is easily avoidable. If the surface of the metal, which it is employed to heat, be of a proper nature, the air is quite healthy; if iron pipes are used, no unhealthy exhalation is produced.

It is now upwards of one hundred years since the use of steam as a heating medium was first suggested. This was brought forward by Col. William Cook, in 1745: since which time, projects and contrivances, in amazing numbers, have been produced, all designed to carry out the principle.

The great advantages of steam over hot temperature stoves is the economy and facility with which it can be produced, and

conducted to any desired situation. The distance of the place to be heated from that where the steam is produced, has no influence in stopping the useful effect; care, however, being always taken that the pipes in which it is conducted shall be protected from cold, in order to avoid condensation.

In making arrangements for heating by steam, the points necessary to be considered are—the place and situation of the furnace and boiler, and the mode of distributing the pipe or heating surfaces ; so as to heat the required quantity of air in the least possible space of time. The furnace should be so constructed, that the fullest advantage may be obtained from the fuel consumed. The first point to be aimed at, is to allow fresh air to have free access to all parts of the grating, or fire bars, on which the fuel is consumed. The freer this is, the more perfect will be the combustion, and consequently the effect derived from it. However, the combustion of fuel must never be pursued to that point at which the gaseous products, and the air necessary to blow the fire, consume more heat than the fuel generates.

The quality of the air to be admitted to the furnace is also of importance: the air ought to be dry and cool; if moist, it takes away heat; if cool, on entering the ash-pit, it passes with greater velocity through the fuel.

It may perhaps be objected to this recommendation, that it is opposed to the practice of having the ash-pits of furnaces supplied with water. In such cases, it must be remembered that the benefit derived from the practice is, that the draught of defective furnaces is increased by the steam which rises from the water, which, mixing with the smoke, renders it lighter. Experience of the working of furnaces shows, that the air supplied to the fuel should be cool, that it may pass with greater velocity through the burning fuel ; and in this the opinion of Tredgold coincided :—" The quality of the air to supply the fire is another thing worthy of being considered, although any dirty wet hole is usually esteemed good enough for the fire-place. Now the air ought to be dry ; for air charged with moisture is improper, and only takes away heat."—*Principles, etc.*, § 91.

The form of construction for the furnace will depend on the species of boiler used ; a cylindrical or longitudinal boiler will evidently be differently circumstanced from a spherical one. As the principal point to be aimed at, is the economization of the fuel, there are certain important matters which ought to be considered in all constructions, whether for the one or the other kind. The object being to confine the heat, non-conductors ought to be used for the external brickwork, or walls, of the furnace, so as to avoid as much as possible the use of metal. The outside brick-work should be built with hard well-burnt bricks, and, if possible, have hollow walls surrounding the space in which the fuel is consumed. The space for the fire and boiler should be lined with fire bricks, set carefully in fire-proof cement. In the generality of furnaces, a flat piece of metal, called a dumb plate, is placed near the door; for which earthenware slabs or fire-tiles should be substituted. The best place for the boiler is where the flame can act at once upon the bottom ; much heat is lost by placing the boiler too far in, as a cold current of air mixes with the flame and hot air every time the fire is stirred. At the place where the smoke leaves the furnace, a damper, made of cast-iron, should be hung, which, although usually made horizontal, should slide in a vertical frame, and be attached to a chain, which, passing over a pulley or pulleys, should have a weight at the extremity, to act as a counterpoise to the damper; by moving this weight up and down, the damper may be moved in a corresponding ratio, and the fire consequently regulated in intensity. The bars whereon the fuel is placed should not be larger than one inch in breadth at the top, and the distance, between each, not more than half-an-inch. To evaporate one cubic foot of water per hour, one square foot of aperture in the grating should be allowed for admission of air to the fuel. If fifteen square feet of surface of boiler are exposed to the flame for every cubic foot of water evaporated per hour, this allowance will be ample, and found consistent with general practice. Of this quantity, one-third is reckoned as horizontal or effective heating surface, the remainder vertical. For the aperture of the chimney, Scott Russell gives as a standard—one-fifth of the fire-grate, diminished at the chimney, to one tenth of the same area. " The chimney should be of the same diameter throughout its interior ; and if of forty feet height, and one-tenth part of the area of the grate, it will give an abundant draught. If the height of the chimney be greater, then this area may be diminished, as the square root of the height is increased". The higher the flue, the greater is the upward current or draught; consequently, if the height is increased, the area may be proportionally diminished: this, as Russell above shows, is as the square root of the height is increased. (*History of the Steam Engine*, chapter on Boilers.) The shape of the boiler generally recommended is the cylindrical, having spherical ends. If very *small*, it should be made of copper, this being the most economical material, as the thinner the metal the better, at the part where it is exposed to the flame. The outer surface, above the brick-work, should not be exposed to the air ; if this be the case, it occasions a very considerable loss of heat: the best contrivance to obviate this, is to have an outer case surrounding the exposed portion, leaving an empty space of some three inches between them ; this should be filled with a non-conducting material, as lime, animal charcoal, etc. A cheaper method would be lining the outside with bricks carefully cemented together. The quantity of water in the boiler is also a matter of some importance. A good proportion will be, ten cubic feet for every cubic foot of water evaporated per hour; and the size of boiler should be so proportioned that this quantity shall fill half of it ; the other half having its capacity equal to, if not a little greater than, the capacity of the range of steam pipes to be filled for heating purposes. To ensure safety, and a proper attention to the quantity of water, etc. in the boiler, certain apparatuses should be used. The safety valve consists of a cylinder fixed to the top of the boiler, having free communication with the interior and the external atmosphere ; on the lower part of this a valve is placed, having a vertical motion ; the spindle or stalk of the valve is loaded with heavy weights at its upper extremity, or is pressed upon by a weighted lever. When the steam exerts a pressure on the under surface of this valve, greater than the amount of downward pressure, caused by the weight of the atmosphere and the load placed upon its upper extremity, the valve rises from its seat, and the steam is allowed to escape to the atmosphere, through the aperture provided in the cylinder. As nothing should be left to the final settlement of workmen, the professional master should himself see that every requisite condition is fully carried out. The following rule is given by Tredgold (*Principles, etc.*, § 103), to decide if the area of the safety valve be of sufficient size :—" It will be obvious that the safety valve should be of such diameter that the steam may escape as quickly as it can be generated by the fire under the boiler ; for, with a less aperture, the steam will accumulate, and the pressure, tending to rend the boiler, will increase, even after it has become sufficient to raise the valve."

A sufficient pressure of steam for heating purposes is four pounds per square inch over and above that of the common atmospheric pressure : this should never be exceeded. It is almost unnecessary to state that this pressure is quite harmless : a pressure fourteen times as great is daily wrought with safety in many parts. If the quantity of water to be evaporated per hour is known, the rule for finding the area of valve is, according to the same authority :—" Divide the number of cubic feet of water that the boiler would evaporate in an hour by five, and the square root of the quotient is the least diameter that should be given to the safety valve."

After the safety valve, the next important appendage to the boiler is the feed apparatus. Fig. 22 is a representation of a simple form of feed-pipe : *a a* is part of the boiler ; the level of water is seen by the horizontal lines ; a tube, *b b*, is inserted in the boiler, passing down within a couple of inches of the bot-

tom. At the top of the tube, a small cistern, *c c*, is placed, supplied with water from the pipe *i*. At the bottom of the cistern a conical valve is placed; this is furnished with a rod, *e*, attached to the end of the lever *f*, working on a standard affixed to the side of the cistern; at the other end of this lever a rod, *g*, is attached, passing downwards through a steam-tight aperture in the boiler's top, and fastened to the upper side of a stone float, *h*. When the valve is in its place, and the lever *f* horizontal, the bottom of the float *h* should rest on the surface of the water. And this line should be that of its proper level. When the water falls below this, the float descends, pulling with it the rod *g*, raising the opposite end of the lever, and, by means of the attached rod *e*, raising the valve out of its seat; the water, flowing from the cistern, down the pipe *b*, to the interior of the boiler, rises in the interior, raises the float, and shuts the valve.

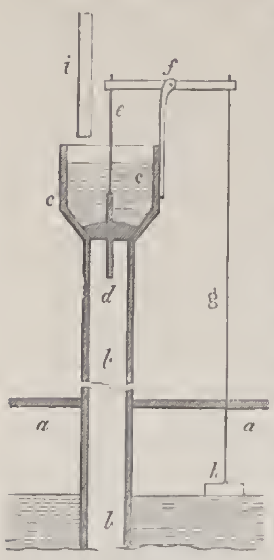


Fig. 22.

One thing should be attended to in this contrivance, namely, to make the height of cistern, from the boiler, sufficient to balance the pressure of steam in the boiler. It will be seen, that when the steam accumulates in the upper portion of the boiler, as it increases in pressure it will press upon the surface of the water, and force it up the feed-pipe, thereby opening the valve *d*, by pressing on its under side. On a rough calculation, a pressure of steam, fifteen pounds to the square inch, will sustain a column of water thirty feet high: so for every pound of pressure of steam, two feet of height should be allowed. It is better, however, to err in excess; so two feet and a half may be allowed. As before mentioned, four pounds of pressure should be the maximum, therefore ten feet will be required to be the height of the bottom of the cistern from the boiler. The cistern should not hold more than what is considered sufficient to keep up the necessary supply. When the pressure of the steam exceeds four pounds, it will force the water up correspondingly, and act in some measure as a safety valve. Tredgold recommends it, in small boilers, as a substitute for the safety valve; it is surely better to have the latter, and the feed-pipe will be a valuable auxiliary to it.

In order to ascertain with ease the relative quantity of water and steam in the boiler, the contrivance called the "gauge cocks" should be used. A tube is inserted in the boiler plate, at any convenient space near the top; this is continued to the water level, and a little below it; the external part of this tube must be provided with a stop-cock. When the water is at its proper level, on the cock being opened, the steam will force the water out of the aperture; if too little water be in it, steam will come from the pipe, and the feed apparatus must then be looked to. Another pipe is in like manner provided, but the tube only reaches to a little above the level of the water. When opened, if steam comes out of it, it is correct; if water, there is too much in the boiler.

Another contrivance (Fig. 23) used for this purpose, is known as the "glass water gauge". A glass tube, *b b*, communicates with the boiler *e e* at top and bottom, by means of the tubes *c c*, the apertures of which are closed by the cocks *a d*; the upper tube opens into the boiler where steam should be, and the lower where the water is. When the two cocks *a d* are opened, water enters below and steam above; and the pressure in the tube *b b* being equivalent to that in the boiler, the level of the water is equal in both; so that by a glance the quantity of water can be ascertained; the stop-cock *f* is used to withdraw the water which remains in the pipe. To ascertain the pressure of steam the "mercurial gauge" is used: a bulb, containing mercury, is attached to the part of the boiler containing steam, in such a manner that when a cock is opened on the connecting pipe, the steam is admitted to the bulb, and presses upon the upper surface of the mercury; a glass tube, open at one end and closed at the other, is inserted at its open end into the mercury, its mouth nearly, but not altogether, resting on the bottom of the bulb; the pressure of steam in the bulb forces the mercury up the tube, in a ratio corresponding to the pressure in the boiler, and the air in the upper portion of the tube is compressed accordingly; if into half its original bulk, the pressure is doubled; and so on.

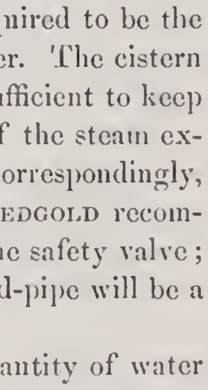


Fig. 23.

A man-hole door should be provided, and carefully covered steam-tight: when the boiler requires to be cleaned, this may be taken off, and entrance to the interior will be gained.

The distribution of pipes for conveying the steam is of great importance; as on this point, mainly, depends the efficiency of the heating apparatus; at least, in obtaining useful effect in the apartment to be heated. The remarks on this subject will also suffice for every form of hot water apparatus; the arrangements in this case being the same in both modes.

As to the materials for the pipes: that which has been universally and justly preferred, is cast-iron, from the great recommendations of cheapness, convenience of working, and ease of fitting up, combined with the absence of any peculiar or disagreeable scents. Copper should not be used in dwelling houses for heating, as a very peculiar odour is always emitted. Lead is sometimes employed for pipes to convey steam, but is wholly unfit for that purpose, because the heat of boiling water expands it beyond its power of restoring itself; and consequently, pipes of lead become larger every time they are heated, and ultimately fail. If it were not for this defect, it would be an exceedingly convenient and economical material for many parts of a steam apparatus. Tin pipes are often used; they are very cheap, but soon decay; when fitted up, valves should be provided, to admit the atmospheric air, if a vacuum happens to be formed in the interior; if this precaution be not adopted, a collapse of the tube will take place on such occasions. The brightened surface should be roughened and made black.

The effect of colour and surface of pipes, with reference to their power of giving off heat, has been much investigated. Tredgold gives the following account of the result of some experiments (*Principles, etc.*, § 115):—"A surface coated with lamp-black, appears to be the most effectual in giving heat (as determined by Professor Leslie's experiments), and a bright surface of tin the least; therefore, considering the effect of tin to be unity, or 1, it will serve as a standard of comparison. Now, according to experiment, it appears that a globular vessel of planished tin, four inches in diameter, filled with hot water, cooled down ten centrigrade degrees in one hundred and fifty-six minutes. When the same vessel was painted on the external surface with lamp-black, it cooled the same number of degrees in eighty-one minutes: that is, the times of giving off the same quantity of heat are as 1 : 0·52, or nearly as 2 is to 1; or bright tin requires double the time to dissipate the same quantity of heat. But in another experiment, where the only difference was a greater excess of temperature in the hot water, the times were as 1 to 0·66. The times to produce the same effect with a bright surface of tin, and one of tin rubbed with quicksilver, so as to give it a splendent lustre, were as 1 : 0·96; but when sufficient quicksilver was added to render the surface a matted white, the times were as 1 : 0·89. When bright tin was coated with bibulous paper, soaked in olive oil, the times were as 1 : 0·55 nearly; but a thin film of oil did not reduce the time so much; the ratio in that case being as 1 : 0·83. Rubbing the surface of the tin with fine sand-paper shortened the time of cooling, and coarse sand-paper still more; in the latter case, the times were as 1 : 0·91. Different thicknesses of the same substance altered the rate of cooling; for the time for bright tin being 1, a coat of isinglass size, $\frac{1}{10,000}$ of-an-inch thick, reduced it to 0·7; a coat double that thickness reduced the time to 0·615; and a coat of ten times that thickness reduced it to 0·53. There is reason,

then to conclude, that mere colour is not of material importance, for it appears that a thick coat of isinglass size was as effectual as lamp-black. This remark is the more required, because in cases where the heating apparatus is to be ornamental, it will not be necessary to adhere *to any particular colours*, but to adopt those which harmonize best with the place". In fitting up pipes, rough blackened surfaces, as they are the most easily obtained, will be found to give considerable satisfaction; they may be blackened, and the rough surface attained by adding coarse emery powder.

The thickness of the metal of which the pipes are formed is a matter of some importance. In some cases, as in green-houses, the heat being required to be given out slowly, thick pipes will be best. In churches, dwelling houses, etc., the thinner they can be made, consistent with strength, the better.

The usual form for heating apparatus is the circular tube or pipe; this of three-eighths of an inch in thickness will be of ample strength. In addition to pipes, vases, pillars, etc., may be made to contain steam, and give off heat to the place in which they may be situated.

In fitting up pipes, due provision should be made for their expansion: if this be one-eighth of an inch for every ten feet of pipe, the allowance will be ample. To allow the range of pipes to have free motion while expanding, the best plan is to place them on rollers. The annexed Figure 24 will explain one mode, when the pipes are placed near the wall: *d* is the wall; *b* the bracket leaded into the wall, supporting the roller *e*, which is placed at right angles to the direction of the pipe *c*. The pipe rests on the roller, and is allowed to move when expanding. The pipes should be placed near the floor of the building to be warmed, and as near as possible to the aperture made for the admission of fresh air.

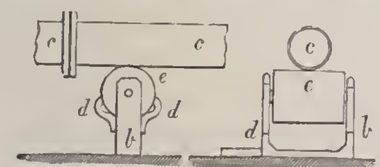


Fig. 24.

The modes of joining the pipes are numerous: the simplest is the flange joint; a ring of vulcanized india-rubber, being screwed up tightly between them, will make a good steam-tight joint. The faucet joint is most frequently used; and when carefully rusted, it is perhaps the best that can be adopted, though not so simple as the flange joint. Fig. 25 shows the end, *a a*, of the pipe, passed into the socket, *c c*, of the pipe *b*. Iron cement is the best wherewith to make good these joints, proportions vary, but the following are usual: four ounces of sal-ammoniac to twenty-eight pounds of iron borings, free from rust and dirt. In using this cement, the ingredients are to be mixed together and moistened slightly with water; the composition thus made is to be forced between the joints with a caulking chisel and hammer: as much only as is required should be made at a time, as it spoils with keeping: if well made, it soon hardens, and expands equally with the iron pipes. Sulphur, often used in addition, produces disastrous effects on the iron and any painter's work. A new method of joining pipes, without any hemp or vulcanized india-rubber, has been recently introduced. The face of the flange is turned truly flat; a small groove, as shown by the dotted line, Fig. 26, is cut therein, and a piece of iron wire let into it as at *a a*: a corresponding groove is let into the other flange. When the two are screwed together, the wire keeps the joint remarkably tight. This plan may be adopted with advantage, as it is a clean and efficient mode. In circular joinings, the best kind of joint is shown in Fig. 27. The ends of the pipe *b* are provided with socket joints, the pipes *c* being inserted with the cement. Joints may be made with flanges, as in Fig. 28. As, in circular junctions, the modes above shown of obviating the effects of expansion, are not available to their fullest extent, Count Rumford's expansion drum joint, Fig. 29, may be adopted. *b b* is a drum of thin copper, of sufficient breadth to allow the requisite degree of expansion in the pipes, so as to allow them to draw out or compress the sides without injury; *c c* represent the pipes joined to the sides of the drum, in a state of tension.

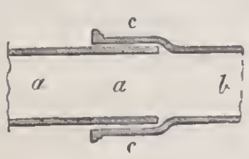


Fig. 25.

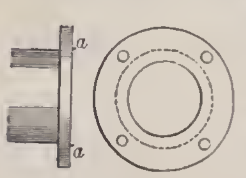


Fig. 26.

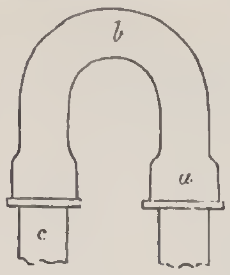


Fig. 27.

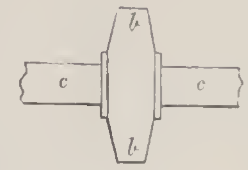


Fig. 29.

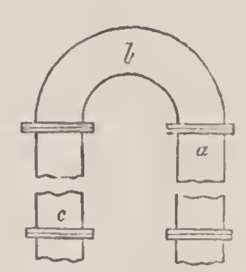


Fig. 28.

In some cases, flat or tabular pipes are used with advantage, in heating the air of an apartment; of course the steam supplied to them can be led by circular pipes. Fig. 30 is a good form of this species of heating surface; a series of flat receptacles, *b b*, are connected together by tubes, the upper one, *a*, supplying steam, the lower one, *c*, leading off the water of condensation; the fresh air passes at *d*, between the flat sides. Another mode of heating by these pipes is sometimes adopted, viz.—the conducting power of iron being so great, projections of this metal are added to the sides of the tubular surfaces; these derive a degree of heat from the steam therein contained, very little inferior to that of the flat casing. Fig. 31 shows this arrangement; where *a* is the supply pipe; the tubular surfaces have the projections *b b*; *c* is the condensed water tube.

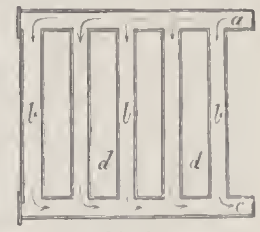


Fig. 30.

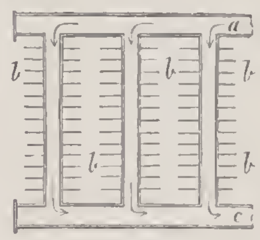


Fig 31.

In placing a range of steam pipes in any building, they should be laid with an inclination to the boiler; so that the condensed water shall be returned thereto. If the pipes be laid horizontally, the condensed water will remain in them; and when the apparatus is used after any cessation, the steam admitted to the pipes being condensed, by coming in contact with the cold water, a vacuum is suddenly formed, and, if the pipes are not strong, they are in danger of collapsing. In some cases, the water giving out its heat after the steam has been shut off from the pipes, it may be advisable to collect the condensed water at certain places, whereat stop-cocks must be attached, by which the water can be withdrawn. These cocks will also serve the important purpose of allowing the air in the pipes to escape, when the apparatus is first put in order. In cases where the water on condensation flows to the boiler, a small return-pipe may be attached to the lowest part of the steam-pipe, through which the water may flow to the boiler. This return-pipe should be made of malleable iron (not lead, for reasons before shown); and if it be required not to give out heat in the places through which it may pass, it should be covered with non-conducting materials. Steam heating pipes should at once proceed to the highest part of the building, and descend to the lowest; at the lowest place the return-pipe should be attached. A self-acting syphon, Fig. 32, by which the condensed water can be withdrawn from the apparatus, given by Tredgold (*Principles, etc.*, § 130), is most certain in its action. *a* is the lowest end of the steam heating pipe; to which a syphon, *d b c*, is connected; the waste of condensation runs off by *c* to the drain or other receptacle: this condensed water, being distilled, may be used for many purposes. In this arrangement, another pipe is provided with a stop-cock, *e*, by which the air in the pipes is blown out at starting. The place made for the reception of the syphon should be lined with materials non-absorbent of wet, and the pipe, when put carefully in its place, rammed round with animal charcoal or other non-conducting material, so that the condensed water may flow off hot, if so required. Care must be taken to prevent the length of pipe in *a b* being too short, as

in this case the water will be overbalanced by the pressure of the steam. Already, in describing the feeding apparatus, the mode of calculating the length of pipe containing water to resist a certain pressure of the steam, has been shown, with the result,

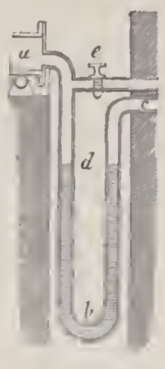


Fig. 32.

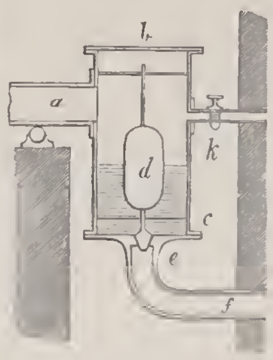


Fig. 33.

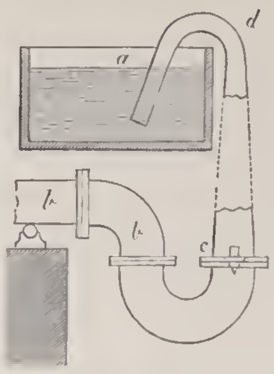


Fig. 34.

that for every pound of pressure on the square inch, two feet and a half of pipe must be allowed; in a case where six pounds is the working pressure, the length of syphon will require to be fifteen feet. As there will be considerable oscillation of the body of water in the syphon, a valve, opening towards *c*, may be placed at *b*. As, in many places, the necessary depth for the syphon pit may be difficult to be obtained, a contrivance, also given by Tredgold (*Principles, etc.*, § 131), may be adopted. (Fig. 33.) Let *c* in Fig. 33 be a square box attached to the lowest end of the steam-pipe; and *d* a hollow copper cylinder, fixed to a conical valve, *e*. When steam is condensed, the square box will fill with water, and float the copper cylinder *d*, lifting the valve *e*, through which water will flow, by the pipe *f*, to the drain; the valve *e* will be closed when the water is too low to float the cylinder. In this case, also, a stop-cock, *k*, is required, to let out the air on first starting. As in some cases it is impossible to have the boiler *beneath* the lowest place where the heat is required, the water of condensation may be forced up to a cistern *above* the level of the lowest part of the pipe, by means of the pressure of the steam. If the pressure is four pounds to the square inch, the height to which the water can be raised must be less than ten feet at most, nine feet to insure its working properly. Fig. 34 shows the plan; where *b b* is the heating pipe, *a* the cistern to supply the boiler, *d* the pipe up which the water is forced; a valve is placed at *c*, opening upwards, to prevent the water from flowing back to *b b*.

If the boiler be at a distance from the place to be heated, as in the case of forcing-houses, the main steam-pipe should be led in such a manner that little of the heat may be lost: this may be done by inclosing it in a box made of zinc or wood, charred on the outside, filled with animal charcoal or other non-conducting material, and placed in a trench or drain fitted with non-absorbent materials, as bricks, or earthenware tubes. Fig. 35 is a transverse section of the box: *a* is the pipe, *b* the box, *c c* the bricks on which it rests.

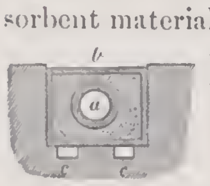


Fig. 35.

In distributing pipes in dwelling houses, if placed behind the skirting board, they will effectually warm the air passed into the room, and be at the same time concealed. In large saloons, the contained air cannot be warmed effectually by an ordinary open fire-place; but, as its cheerful appearance is much and justly esteemed in this country, it must be provided. Yet, at the same time, the heat from pipes should be combined with it. If the pipes, in such a case, cannot conveniently be placed behind the skirting board, they may be masked by some ornamental piece of furniture, as tables, etc. The pipes will be placed in masses, or a series of coils,—or, instead, the pipes may be placed beneath the flooring; the heated air escaping through apertures made in the floor. But wherever they are placed, it will be essentially necessary that fresh air should have free access to them, and to the room, on being heated to the corresponding degree required.

Much ignorance prevails as to the good effect to be obtained from a gradation of heat. A room having the temperature of 60°, is considered by a person sitting therein as by no means warm; but by another, entering from a frosty atmosphere, the heat may be thought oppressive. If a person passed through a hall heated to a temperature varying from 45° to 55°, he would be accustomed to the heat of the room, and *vice versa*.

Pipes, as before described, may be arranged in decorative covers, or simply placed behind the skirting. If it could be arranged, the better way would be to have them near the centre of a hall. In the case of a central staircase, the air may be heated by placing a steam or hot water stove near the bottom. A simple and inexpensive form of heating apparatus is a cylinder of metal, shown in Fig. 36, having double waterproof sides, covered with a decorative casing: the cold air rushes through apertures in the bottom of the casing, and some of it passing up the centre, *a*, and the remainder along the outside, *b b*, is heated, and escapes through apertures made at the upper side of the casing. In the arrangement of heating pipes in the interior of a church, public hall, or other large building, the utmost effect will be obtained by placing the congeries, of heating surfaces, beneath the perforated flooring (Ventilation), a range of pipes running before all the apertures made for the admission of fresh air; this will cause the entering air to be heated at once. If the air be led to spaces in the passages, a flat perforated steam-box may be placed in the space beneath the grating, so that the air entering will pass over the heating surface. Fig. 37 is a sketch illustrative of this arrangement. *a* is the fresh air ventiduct: *b* the grating covering the space made in the passages; *c c* the flat perforated box connected with a steam boiler or hot water apparatus. This box will be easily made of zinc. The tubes passing through it in the direction of its thickness must be water-tight, at the place where they join the top and bottom plates of the box; the water of condensation is to be led away, by proper means. Instead of this box, a congeries of pipes, some inch and a half diameter, may be used. In some cases, the heating pipes may be led along the walls, at the places where the fresh air is admitted; but in the instance of a church, where pews are there situated, the parties sitting therein will feel the heat more decidedly than those in the body of the church. Pedestals, made hollow, may be placed with advantage in the entrances below the gallery staircases, and also at the space generally left before the pulpit. The following, Fig. 38, will give an idea of these arrangements. *a a* are the apertures made in the outside walls, for the admission of fresh air; *c c* the range of pipes running before these; *d d* the hollow pedestals, containing steam or hot water; *b b*, passages: if the heating surfaces be placed in each passage, the letters will denote their situations.

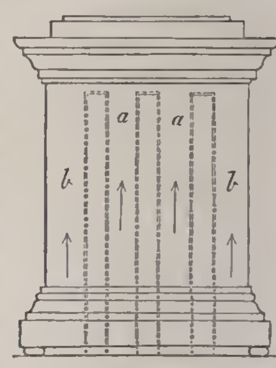


Fig. 36.

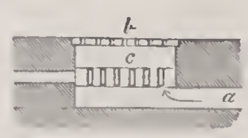


Fig. 37.

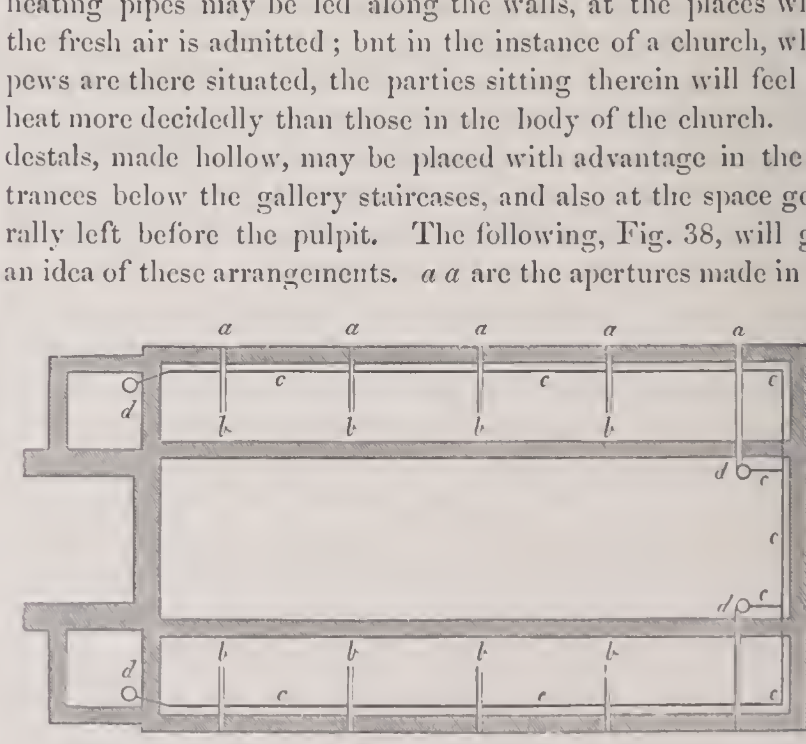


Fig. 38.

As it may be considered desirable to take down the defective apparatus, and fit up one better calculated to give healthy heat, in some extensive buildings already constructed, having a large chamber for heating made below the level of the floor, the following illustration is appended, of a very efficient form of apparatus, designed for a separate chamber: the heating medium being

steam; but hot water pipes may be substituted. In Fig. 39, *a* is the furnace; *b* the boiler; a chamber, *c c*, is made at the end of the boiler furnace, of dimensions sufficient to contain the requisite area of pipe; this chamber should have a domed roof, in the centre of which the pipe *d*,

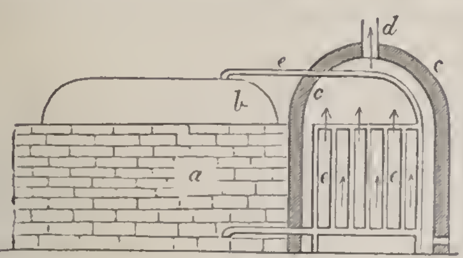


Fig. 39.

for leading the heated air to the interior of the church, etc. should be placed. A range of vertical pipes, *e e*, are placed within this chamber; and the air admitted, to pass along them by apertures made in the brick-work, near the ground. The air thus led to it should be brought by pipes or wooden boxes direct from the open air. When the steam is admitted from the boiler to the pipes, the air passing upwards is heated, and escapes by the aperture *d*. A small pipe should be connected with the lowest part of the congeries, so as to afford facility for drawing off the condensed water. The whole of the pipes should be connected with one another. If this be well made it will give great satisfaction, in cases where it is thought desirable to send heated air into the building, without the intervention of pipes, pedestals, etc.

The first step in the investigation of the requisite area of pipe for any desired building, will be the quantity of cubic feet of air required per minute. In order to ascertain this, attention must be given to the loss of heat by ventilation, and the direct influence of cold external walls, glass windows, etc. From the first cause there will be a loss of heat proportioned to the quantity of air withdrawn per minute: if four cubic feet are supplied to each individual per minute, then "there will be for each individual four cubic feet of air per minute, conveying off a quantity of heat equal to the difference between the heat of the external air and that of the room." Thus, if the heat of the room be 70°, and that of the external air 50°, then it is clear that the withdrawal of four cubic feet of air per minute must lead off a quantity of heat equal to the difference between 70° and 50°, or 20°. In other words, the ventilation causes a certain loss of heat, which, in a close room, with the air stagnant, would not be the case. From the second cause there will also be a loss, as heat is transmitted very quickly through glass: the quantity of air cooled in a given time being simply proportional to the surface of the glass exposed to the external air; and, consequently, will be constant, whatever variation of temperature may take place. The rule given by Tredgold (*Principles*, etc., § 67) for finding the quantity of air that will be cooled, per minute, from the temperature of the room to that of the external air, is as follows: "If the area of the surface of glass be multiplied by 1·5, the product will be the number of cubic feet of air per minute which will be cooled from the temperature of the room to that of the external air"; and to this loss will also be added that arising from each door and window (independent of occasionally opening and shutting the former): this was calculated, by the same author (§ 65), to be equivalent to eleven cubic feet per minute, the difference of temperature between the internal and external atmosphere being 60°.

From a combination of these circumstances, assisted by various experiments, Tredgold (§ 68) deduced the following rule: if the number of people the room is intended to contain be multiplied by four (or according to the quantity of air allowed per minute), and added to eleven times the number of external windows and doors (as eleven cubic feet of air is passed through each per minute on an average), added to one and a half times the area in feet of the glass exposed to the external air, the sum obtained will be the quantity, in cubic feet, to be warmed per minute.

The next operation is to find the surface of pipe which will heat this quantity of air. The mean temperature of steam-pipe, at the ordinary pressure, is 200°. To make this calculation, the temperature of the external air, or of the air that supplies the ventilation, is to be known at the extreme case of cold, which, for the day, may be taken at 30°, but, for night, may generally be assumed to be at zero of Fahrenheit's thermometer, as the cold is seldom more intense in this climate. The temperature at which it is proposed to maintain the room, or place to be heated, at the same season of cold, is also to be settled; and (fixing the mean temperature of steam-pipe, at the ordinary pressure, at 200°) Tredgold (§ 44) also gives the following rule: multiply the cubic feet, per minute, of air to be heated, to supply the ventilation and loss of heat, by the difference between the temperature the room is to be kept at, and that of the external air, in degrees of Fahrenheit's thermometer, and divide the product by 2·1 times the difference between 200 and the temperature of the room. This quotient will give the quantity of surface of cast-iron steam-pipe that will be sufficient to maintain the room at the required temperature.

The examples by the same author may be condensed. A staircase, hall, and two passages are to be maintained at 56°, when the external temperature is at zero. There are two windows, each 10 by 4 feet, in the hall; a skylight in the staircase, the superficies of which is 100 feet; two windows in each of the passages, each 7 feet by 3 feet 6 inches; in all 278 superficial feet of glass: this multiplied by 1·5=417 cubic feet cooled per minute. The loss from ventilation, by the skylight, placed 30 feet from the floor (Tredgold, *Principles, etc.*, § 136), and the other openings, will be 275 cubic feet per minute, 417 × 275=692 cubic feet per minute to be warmed. By the rule, the quantity of heating surface will thus be found: $\frac{692 \times 56}{2{\cdot}1 \times (200-56)}$=128 feet of surface of steam-pipe. In a room containing 1,200 people, containing 100,000 feet of space, the number assembled being, in winter time, on an average, 600, where the surface from 28 windows is equal to 1,000 square feet, and the heat to be maintained, 60°, the external air being 30°, the loss from the glass surface will be 1,500 cubic feet, from ventilation 2,400, and from windows, doors, etc., about 300—in all, 4,200 cubic feet: then by the rule, $\frac{4{,}200 \times 30}{2{\cdot}1\ (200-60)}$=428 feet of surface required. According to Dr. Arnott, one foot of superficies of heating surface is required for every six square feet of glass; the same for every 120 feet of wall, roof, and ceiling; and an equivalent quantity for every six cubic feet of air withdrawn from the apartment by ventilation per minute (Tomlinson, *Rud. Treat.*, p. 124).

Tredgold's *Table of the quantity of Steam that will fill a given Length of Pipe, and of the Length of Pipe for one foot of the Surface.*

Interior Diameter of Pipe.	Length of Pipe that will contain one cubic foot of Steam.	Quantity of Steam in one foot in length of Pipe.	Length of Pipe that has one foot of exterior surface.
Inches.	Feet.	Feet.	Feet.
1	183	·00545	3·28
1½	81	·01225	2·18
2	46	·02182	1·63
2½	29·2	·034	1·31
3	20·3	·049	1·09
4	11·5	·0873	0·82
5	7·3	·1363	0·66
6	5·1	·1964	0·55
7	3·7	·267	0·47
8	2·9	·349	0·41
9	2·25	·442	0·36
10	1·83	·545	0·33

In order to obtain the full effect of a steam heating apparatus, economically, great attention must be paid to the firing of the furnace. The best mode is to fill the space at the front of the fire with fresh fuel, with the damper pulled only a little way up, so that the draught may not be too strong. The fuel will be gradually heated, ready to enter into combustion, when pushed forward by the stoker; and a new supply of fuel should then be added, in the place of that which has been thrust forward into the fire. The gases which distil, from the fuel having to pass over the red-hot embers, which are to be supplied with air from the ash-pit, will generally be wholly consumed in passing the throat of the chimney. In raising the steam, the quickest mode of

firing is to supply fuel frequently, but in small quantities, spreading it as thinly as possible over the grating.

Where power is used in a building, for ventilating or other purposes, in connexion with a steam heating apparatus, self-acting machinery may be used with advantage for feeding the fire.

The revolving grate (the patent of which has expired), will give satisfaction. Its principle of action of contrivance is as follows:—the grating is made circular, and is capable of revolving: the coals are showered down upon this grate as it passes a slit made in the boiler, near the furnace mouth. The smoke evolved from the fresh coal is consumed by passing over the clear burning portion, which has formerly had its smoke consumed during the revolution of the grate. Jucke's Patent Furnace is highly spoken of as a self-feeding arrangement; with bars, in the form of an endless chain; the coal being carried forward gradually as it is burned; as the chain turns round the furthest carrying roller, the ashes and clinkers are precipitated into the ash-pit.

When pipes exceed six inches, in order to give the requisite degree of surface, two or three smaller pipes would be better; and in order that they may give out heat, even after the steam has fallen down, TREDGOLD (§ 17) recommends pebbles, etc. to be placed in their interior. This arrangement will certainly, at the first starting of the apparatus, cause a large portion of the steam to be condensed, by coming in contact with the cold pebbles; but this loss is only apparent, as the heat thus taken up will afterwards be given out: but disadvantages will immediately occur to the reader.

The last division of this subject now remains for consideration: viz.,—raising the temperature of air by passing it in contact with the external surfaces of pipes or receptacles containing hot water.

In consequence of the greater simplicity of action, and the ease with which it is maintained in operation, hot water apparatus possesses many advantages over that of steam; in which, from the multiplicity of appliances necessary to keep it in operation, and to ensure its safety, derangement of the parts sometimes ensues; and the consequences, if not dangerous to those who may be near it, are, at all events, destructive to the apparatus, in a greater or less degree, according to the nature of the accident. On the contrary, no danger need be apprehended from the use of hot water apparatus; even in the high pressure form, the risk of explosion, as hereafter shown, is very slight. Another advantage which hot water possesses over steam is, that after the water is once heated, so long as it retains its heat, even if it be only one or two degrees above the temperature of the surrounding air, the circulation is maintained in the pipes, and heat is communicated to the air: the water can thus give out heat long after the fire is extinguished. With steam, the moment the fire is extinguished, the heating effect of the pipes begins to be lost; for as soon as the temperature falls beneath the boiling point, the steam is condensed; and although the pipes may (and do in some instances) for a considerable time give out some heat, this effect is speedily suspended. Again, a small fire, maintained in a state of slow combustion, keeps up a sufficient circulation, in the hot water pipes, to give out a considerable heat; while to keep "steam up", as it is termed, close and careful attention is requisite, to have the fire in a state of vivid combustion.

The plan of heating by hot water affords a beautiful instance of the application of principles, as indicated by science, to the useful purposes of every-day life. Its introduction dates from an early period; about the year 1716. Sir Martin Treewald, of Newcastle-on-Tyne, heated a hot-house by the circulation of hot water in pipes, the boiler being placed outside. It was, however, in France that it was successfully adopted on a large scale. In the year 1717, M. Bonnemain introduced an apparatus for the hatching of chickens, in which the heat was maintained by a congeries of pipes containing hot water. In 1816, the Marquis de Chabannes re-introduced the system into England, and strenuously advocated its adoption. But it was not until Mr. Atkinson took it in hand, and by his practical modifications freed it from many difficulties, that the invention was largely used.

The circulation of hot water particles in pipes is caused by the unequal density of the fluid, arising from the difference of temperature in the ascending and descending columns of water connected with the heating reservoir; and its velocity is governed by the height of the columns (BRAMAH, *Appendix to Tredgold*). If heat be applied at *a*, Fig. 40, at the bottom of a tube, *b*, filled with water, the currents will be in two directions; the particles ascending being warm, and those descending being cold. The circulation is thus kept up by what is termed the process of "convection". Heat is communicated to solid bodies by the process of conduction. In the heating of water the process is different: water is one of the worst conductors of heat; a vessel full of it may be boiled at top, by applying heat thereto, without raising in any material degree the temperature of the mass beneath;

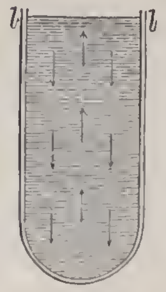


Fig. 40.

the water below, if warmed at all, being raised in temperature almost solely by the conducting power of the material of the vessel in which it is contained. The particles of water being possessed of extreme mobility, move amongst one another with the slightest force. When heat is applied to the bottom of a vessel containing it, the whole mass becomes warmed in the following manner. The particles next the fire becoming heated, expand, ascend, and distribute their heat to other particles surrounding them, until their temperature is equal to the particles they reach; the cold particles, descending and coming in contact with the heated surface at the bottom, are heated, expand, and rise, in their turn; this process goes on till the water is all equally heated; when, under certain circumstances, it passes off under the form of vapour or steam. The vessel containing the water, however large, as in the case of ranges of pipes, communicates its heat to the surrounding air by conduction; the temperature is thus decreased, and a descending motion is the consequence. In fact, in every properly constructed hot-water apparatus, as the pipes are continually throwing off their heat, so perfect quiescence of the contained fluid may be said never to occur, the particles being in continual motion.

As illustrative of the arrangements of a hot-water apparatus reference may be made to Figs. 42 and 43 below; where *a* is the boiler, *b b* the ascending pipe leading to the supply cistern *d*, the descending pipe *c c*, which gives out its heat when required, communicating with the lower part of the boiler *a*; so long as the heat in the boiler is maintained, so long is there an ascending and a descending current. If the pipe *b b* be not intended to give off heat, it should be wrapped round with non-conducting materials; by keeping this mode of confining the heat in view, any part of a pipe may be prevented from throwing out its heat.

The force of the motive power, with which the water returns to the boiler, depends upon the difference between the specific gravities of the ascending and descending columns; when the difference is slight, the motive power is reduced to a small degree; practically it is in all cases sufficient to maintain the circulation. The motive power being in all cases, however, of very slight force, all obstruction in the pipes, as well as sudden turns, or right angles, should be carefully guarded against; a very slight obstruction is sufficient to stop, at least to materially alter the effect of the current. Before being fitted up, therefore, the interior of the pipes should be carefully inspected, and cleaned out. A considerable loss of motive power is sustained through friction; the pipes should therefore be cast as smooth as possible, and the joints perfectly straight, and close up to one another.

The higher the column of hot-water pipe is, the more force will the water have in circulating. In cases where this altitude is unattainable, the same result can be obtained by having the difference of temperature, between the ascending and descending columns, increased; an effect equal to the heightening of the columns is in exact proportion to this difference; if the temperature be doubled, the result is equivalent to doubling the height. The mode of attaining this difference of temperature is by

increasing the surface of the heating pipes in the descending column; so that in a less space of time more heat is thrown off.

With the same quantity of water, a larger surface may be obtained, by adopting the flat tubular pipes shown in Figs. 32 and 33.

Fig. 41 is a diagram, illustrative of a heating stove, or boiler, which not only warms the place in which it is situated, but keeps up a supply of water to ranges of pipes or pedestals in other apartments. A cylindrical vessel, *d d*, is provided with an interior furnace, *a*, having a chimney, *g*, to carry off the products of combustion, the fuel being introduced by the lid *h* at the top; an external decorated covering is placed as at *c c*, with holes perforated at top and bottom; and the fresh air, entering at the bottom, passes up the space formed between the interior of the decorated casing and the exterior of the internal boiler, is heated by coming in contact with the latter, and escapes at the top of the casing into the room. The pipe *e* will carry the hot water to another room, where it may be attached to a vase, pedestal, or range of pipes. The cooled water pipe, *f*, communicates with the under part of the boiler.

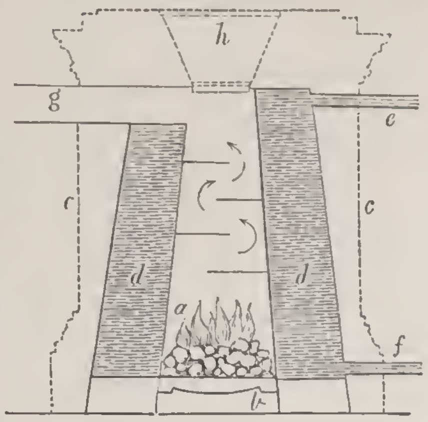


Fig. 41.

In such a low temperature hot water apparatus, the three requisites are—the boiler, or heating furnace, the cistern, and the heating pipes.

In Fig. 42, *a* is the boiler; *b b* the ascending pipe, through any number of floors; *d* the supply cistern, or expansion box; *e* the pipe for the escape of the vapour to the atmosphere; *f* the water supply pipe; *c c* the descending pipe; and *g* the thermometer.

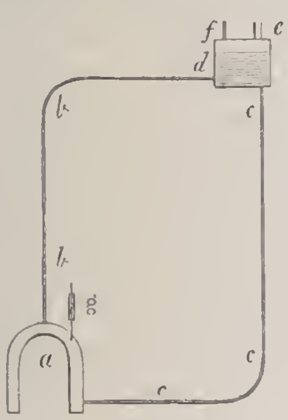


Fig. 42.

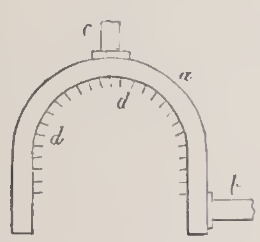


Fig. 44.

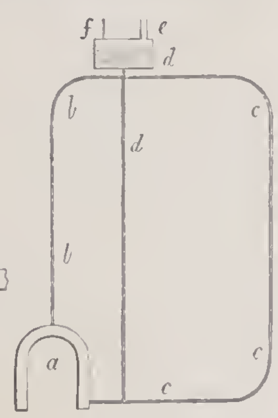


Fig. 43.

Fig. 43 is another form of apparatus; where *d* is a pipe leading from a cistern to supply the boiler. In Fig. 44, *a* is the boiler, *b* the return pipe, *c* the ascending pipe; the inside of the boiler is sometimes provided with projecting ribs of iron, *d d*. The conducting power of the metal being great, the flame and heated air, which might otherwise be comparatively lost, are advantageously used; the surface receiving heat being increased.

While treating of steam heating, it was shown that for every fifteen feet of boiler surface exposed to the fire, there will be one cubic foot of water evaporated per hour: from this is deduced the rough calculation, that for every fifty feet of four-inch pipe, one square foot of boiler surface is required.

The higher the cistern is above the boiler, the greater is the pressure in the lower portions of the pipes; hence the difficulty of keeping joints tight where the pressure is great; yet the cistern or box wherein the water expands must be higher than the level of the highest place to be heated. The expansion box should be covered in, and have a pipe communicating with the external atmosphere, to allow the vapour or steam produced by overheating to escape. A pipe leading from a cold water cistern should supply the expansion box with water, to make up for the loss by evaporation and leakage. If the box or cistern be not designed to give out heat, it should be covered on the outside with non-conducting material. A thermometer may be inserted, to ascertain the temperature of the water, at any part of the tubes required.

The ascending pipe should proceed from the highest part of the boiler, and be finished at the lowest part of the cistern, supply, or expansion box. The descending pipe should leave the lowest part of the cistern, and communicate with the lower portion of the boiler. Care should be taken to have the pipes and boiler of sufficient strength to resist the pressure to which they will be subjected: this increases with the height. On a rough calculation, the pressure exerted on any body subjected to that of a column of water, is one pound on each square inch for every two feet in height; or, as some calculate, thirty-four feet in height gives fifteen pounds pressure to the square inch. The principle on which a barrel full of water is made to burst, by screwing a long tube to its upper end, and filling this tube with water, results from the fact that the pressure is as the height or depth, and not influenced in any degree by the size, shape, or extent of sectional surface of the pipes or vessels.

In joining pipes, the socket or faucet joint is decidedly the best, well caulked and rammed tightly up with iron cement.

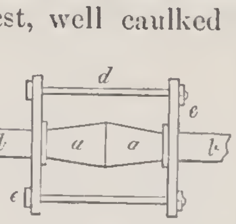


Fig. 45.

Mr. Perkins's method of joining pipes of cast-iron is highly ingenious. At the end of each pipe, *b b*, Fig. 45, to be joined, conical portions, *a a*, are attached; their edges, being truly turned, are pressed closely against each other by the screw-bolts, *d d*, passing through the flanges, *e e*.

In heating large spaces, there has been much discussion relative to the best form of heating surfaces to be used. Round pipes of large diameter were first introduced; they are, however, clumsy, and when filled with water, very heavy; moreover, when used in private houses, the walls, etc. are often much cut up, to admit pipes of so large a bore. It is, indeed, a very difficult matter to get the requisite quantity of heating surface from these pipes without spoiling the appearance of the apartment in which they may be placed. The only point in their favour is their containing so great a quantity of water; they are in fact reservoirs of heat long after the fire is extinguished.

The next improvement in heating surfaces was the adoption of square pipes or tubular vessels (Figs. 30 and 31). When first introduced they were made of cast-iron plates, bolted together by projecting flanges. This clumsy plan was soon discarded, and they are now very neatly made by welding the plates together. The distance between the plates is generally one inch; and the series of receptacles one inch and a half apart. Compared with circular pipes, the quantity of heating surface obtained is about as three to two. This constitutes the value of this form of heating surface. As these plates give off heat very rapidly as compared with pipes, a proportional increase of fuel consumed in the furnace is necessary. This apparent disadvantage is, however, counterbalanced by the comparatively short time the apparatus is required to be in action, and by the small weight of water contained in the receptacles, in proportion to their surface. One objection to the flat receptacles is, that when under a high pressure, the welded joints are apt to give way; the force on an extended surface being very great. In fitting them up, it is evident that any degree of decoration may be given to them; even strips of cast-iron ornament, or moldings at the top and bottom, will constitute, being metallic, effective heating surfaces.

In arranging the position of the pipes, the points to be considered are—their distribution so that each apartment shall be effectively heated to the temperature required; and their levels so adjusted that no air may accumulate in any part, and impede the circulation. With reference to the first point, it will be seen that when the hot water is taken up at once to the supply cistern, the descending pipes nearest the cistern will give out more heat than those placed in the lower apartments, near the boiler; the water, by the time it reaches there, being deprived of a considerable portion of its caloric. The simplest method of effecting the desideratum, in this case, is to have the hot water

taken directly to the cistern; and led from this, by separate ranges of pipes, to the various apartments to be warmed; taking care to cover the pipes until they reach the place in which they are to give out heat. The circulation may be stopped in each range, by having cocks attached at convenient places. The apertures in the cistern leading to the various ranges may be made conical, with corresponding plugs, fastened to the sides of the cistern by chains. The various ranges should be numbered, and the plug apertures correspondingly marked; so that the desired range could be shut off at once, by inserting the plug belonging to it. To prevent the accumulation of air in the pipes, air-cocks and pipes should be attached at the places where the pipes change their level. However small the descent may be, this should be carefully attended to, as a very slight alteration has often been found to render the accumulation of air so decided, as nearly to destroy the usefulness of an apparatus, though in every other respect fitted up with the utmost care. If the air-vent were to be made at part of a pipe at *a*, Fig. 46, the accumulated air would be withdrawn from *a b*, but none would be taken from the portion between *c e d*, as it would have to descend through the pipe *d b*, filled with water, which, as air is lightest, is an impossibility. It is clear, then, that the difference of level, even of a short distance, should be attended to; half an inch militating against the working of an apparatus, as much as half a foot. If the circulation in a low temperature apparatus be stopped, and there be any certainty that the pipes were carefully cleaned out, and freed from all internal obstructions when fitted up, then the levels should be examined; and at every change, air tubes should be attached; if the air tubes be carried to a level higher than that of the supply cistern, they will be self-acting, requiring no stop-cocks. The water with which to supply boilers is of some importance; that which is free from all carbonaceous deposit being best. If the apparatus be not used for a certain portion of the winter months, the water had better be taken out of the pipes, lest the water freezing in them should burst them.

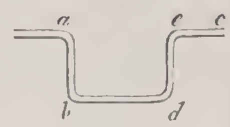


Fig. 46.

In the species of hot water apparatus here described, the heat of boiling water cannot be exceeded, the pipes being open to the atmosphere; it is consequently called the "low temperature" apparatus. The "high temperature" apparatus, as introduced by Mr. Perkins, a highly philosophical system, carried out by constructive details of great ingenuity, remains to be noticed.

It may be simply described as the process of placing water in a coil of pipes, of small diameter, closed so as to prevent all communication with the external atmosphere; and thereafter of applying heat to the lower portion of the coil, by which the temperature of the contained water can be raised to a very high degree. By this apparatus, a heat of 300° or 400° can be so easily obtained, (although there is no reason why the temperature may not be maintained at a much lower heat,) that here lies one objection to the plan: the high temperature thus raised is as influential, in burning the air coming in contact with the pipes, as the highly heated surfaces of high temperature stoves. This objection is very valid, and, in the opinion of many, militates much against the general introduction of the plan. The only way of obviating the difficulty, is by covering the coil of pipes with external plates, by which any required degree of reduced temperature may be obtained.

As the expansive force of water, when heated, is very great, due care is taken, in fitting up the pipes, to allow space for free expansion. This is obtained by having, at the highest portion of the pipes, a length of tube, two and a half inches or three inches in diameter, in which the water is allowed to expand. The proportion which this tube should bear to the small pipe, varies in practice from ten to twelve feet per cent.; one-tenth of the space of piping may thus be allowed for expansion.

In this form of apparatus, the great novelty in the adaptation of the heating power is the absence of a boiler; which is no less elegantly than effectively supplied, by having a coil of the small tubing, placed in such a way that the surface of at least one-sixth of the whole piping is subjected to the heat of a furnace, in which the coil is placed. The forms in which this is done are various. The tube from the furnace is led direct to the expansion tube, which is placed at the highest part of the building where the heat is required; and from this any number of columns may be led to the various apartments to be warmed; uniting, and entering the coil at the furnace. There is no necessity for having the furnace in the same building with the heating coils; it may be completely outside, care being taken to cover, with non-conducting material, the pipes, when not required to give out heat.

Fig. 47 will explain the arrangement of a hot-water high temperature apparatus for warming a range of apartments, A and B; *a* is the boiler, or coil of pipes in the furnace; *e e* the descending pipe, coiled in a mass, in the inside of the ornamental casing *d d*, placed on the floor of the rooms; the tube entering the bottom of the coil *a*. Wherever the coils are placed to give out heat, to insure a speedy current, a good supply of air should be provided. In placing the pipes behind skirting, care should be taken to protect woodwork, as it is a perfect possibility that the heated air may rise to such a temperature as to cause combustion. A very little addition to the temperature of many hot-water apparatuses, would easily ignite combustible materials. For remarks on this subject see "The Builder" *for June* 20, 1850. To prevent the temperature in any case from exceeding 325°, a heat sufficient for all purposes, the expansion tube *c* has been provided with a safety-valve, loaded with a pressure of ninety-one pounds to the square inch, which would on opening allow the water to escape, and flow into a receptacle provided for it. It will be seen that this is a bad practice, because the loaded valve subjects the apparatus to a constant pressure which in working it does not always have; and because, when the expansion exceeds the pressure of the valve, the water is driven out, the coil is destroyed, red hot vapour is formed, and danger arises: the true remedy is the proper proportioning of the coil or boiler to the radiating surface. By exposing malleable iron to long continued high temperature, it loses its fibrous nature, and becoming crystalline, its cohesive force is much lessened; hence the advantage to be derived from preventing a great overheating of the pipes. Although, with good workmanship, there is no difficulty in making tight joints for a low pressure (up to 50 lbs. on the square inch) apparatus, yet before the introduction of Mr. Perkins's plan, the leakage of pipes, large or small, was a constant source of annoyance: the desideratum, then, was a joint which would be rendered tighter by the expansion of the pipes. This Mr. Perkins has succeeded in effecting, in a peculiarly satisfactory manner. If the ends of the tubes, being applied to each other, are both screwed with a right-handed thread, as the common gas-pipes, the turning of a socket, tapped to match, round the two ends, draws only one in, and pushes the other out. But if the ends be screwed, the one with a right, the other with a left-handed screw, the turning of a socket (tapped to match) will draw the ends together. The tubes, then, being thus screwed, and made three-sixteenths of an inch thick, one end is turned in a lathe perfectly flat, which affords a good bearing for the end of the other pipe, which is brought by the lathe to a sharp edge; the socket being then forcibly turned by a pair of long handled tongs, drives the two ends together, till the sharp end is firmly imbedded in the flat one. With such a joint, it is clear that the more the pipes expand, the more forcibly will the joint be tightened; and the pipe will fill the socket, fitting more tightly the more the screwed part of the pipe expands. The superiority of this method of making joints over any that could be applied to the large round or flat tubes, is the highest recommendation that Perkins's method could possibly possess over the other; since in

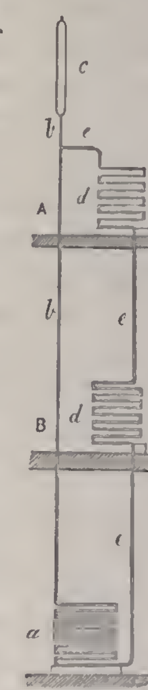


Fig. 47.

that method alone can perfect security be found. When we consider the annoyance of an escape of water, the damage a handsome building may sustain by it, and the expense incurred in repairing such defects, its preeminent advantages must be strikingly obvious. And if we suppose the possibility of an escape from the small tubes, it is trifling compared with that from the other kinds, the least capacious of which requires eight times the quantity of water, nearly the whole of which may leak out. (*On the Comparative Merits of the various Systems of Warming Buildings by means of Hot Water.* Dublin: 1837. pp. 11-13.) But the experience of many years has fully proved, that if this species of joint is left sound, no leakage takes place afterwards; it will last as long, in fact, as the pipes to which it is attached: *in the furnace portion this duration is not always calculable.*

After the pipes are fitted up, and previous to the fire being lighted, the air is forced out of them, by passing volumes of water several times through the whole range; they are then completely filled, the expansion tube being left empty. The pipe by which the apparatus is filled is situated at the bottom of the expansion tube: when the apparatus is filling, the latter is left open, till filled, and the air expelled from the pipes. The filling and expansion tubes are hermetically sealed, by plugging them with screw-plugs.

In both forms of apparatus (low and high temperature), objections have been made, that in cases of bursting, the danger would be great, from the hot water being scattered about. The fact is, that an explosion—which, by the way, very rarely happens—is not attended with dangerous consequences. In the "low temperature" apparatus, if a pipe were to burst, a simple crack would probably be the result: the water would not spread with much force, as, unlike steam, it has a very limited range of elasticity. In the "high temperature", the water being under high pressure, would issue from the crack or fissure at first in the form of steam, thereafter in that of water, at 212°. Those who have to do with the manufacture of both species of apparatus, express themselves perfectly willing to stand within a few inches of the fissure at the time of rupture. That there is little chance of bursting in the "high temperature" may be judged from the fact, that the pipes are proved at a pressure of three thousand pounds per square inch, and every care is taken in their manufacture to prevent unsound work.

Where heating surfaces of great extent are required, a practical difficulty arises, from inability to provide the necessary space for the pipes, as set up in any of the usually applied forms, more especially in connexion with steam and low temperature hot-water apparatus. In these, a large quantity of hot water or steam is required; hence a large space is occupied to obtain a small effect. The annexed, Fig. 48, is an illustration of a plan, which, it is obvious, will afford a large amount of heating surface, with a small cubical content. A box, of which a transverse section is seen at B, is provided with pipes running longitudinally through the interior: these are surrounded by water or steam; the surface presented by each of the internal tubes will, it is evident, heat the air effectively which passes through them: a longitudinal section is seen at A. If hot water be used, it enters

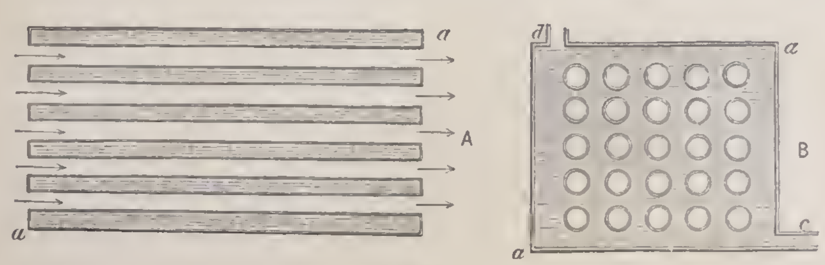


Fig. 48.

the box at the upper side, by the pipe *d*, leaving it at the lower, by the pipe *c*. The apertures, or internal surfaces, may be made in the shape of longitudinal slits, having flat instead of circular sides. By this arrangement, a large amount of surface will be obtained; a box, twelve inches high, and six inches square, giving from its sides above two square feet of surface; but if four slits or apertures be made to pass through its whole length, half-an-inch wide between their sides, and five inches long, so that space will be left at each end to allow the hot water or steam to circulate round and surround them, four additional feet will be given with the same size of exterior surface. Were this principle to be more generally adopted, greater satisfaction would be obtained, from having to provide less spaces for heating surfaces. The practical difficulty would be making the joints perfectly tight.

Mr. Walker has recently invented and patented an effective form of heating box, which presents a large effective heating surface, yet is, at the same time, simple in its arrangements; and will be kept easily in repair. The inventor describes it as "consisting of a number (more or less, according to the heating surface required) of iron blocks, say six inches square by twelve or fourteen inches high (Fig. 49), each block having square openings, cells, or perforations, passing through it, from the top to the bottom, in a vertical direction. The divisions between the perforations are made extremely thin, so as to require the smallest possible quantity of metal; and the blocks are enclosed within an iron box, in such a manner as to leave one inch for water or steam all round each block. The top and bottom of the box have each square openings, corresponding with the ends of the blocks, so as to permit the ingress and egress of the air to and from the perforations. The box may be quite plain, or ornamented to any desired degree, by metal work; when its exterior, and also the internal perforations, are all efficient heating surfaces. Heat, being applied to the outside of each block, by the passage of hot water or steam into the box, is conducted or communicated through the divisions, and the air contained in the cells or perforations becoming also heated, by contact with the hot surfaces of the divisions, rises into the apartment. The box being fixed over any opening in the floor or wall, communicating with the external atmosphere, a constant stream of fresh and warm air is maintained. The heat may be regulated, or entirely shut off, by a stop-cock in the pipe that supplies the hot water or steam; and the quantity of air may be varied at pleasure, by the ordinary slide, or other valve, fixed in the opening. By this very compact arrangement, one hundred and sixty-six feet of heating surface may be obtained, in a box measuring not more than two feet cube, and no outer casing is required".

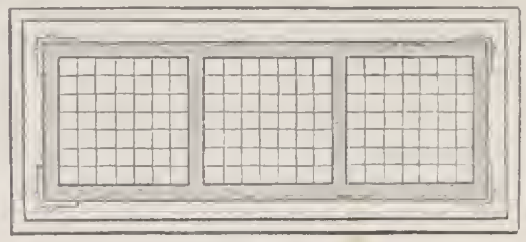


Fig. 49.

From a strict examination of the principle, and a careful series of experiments as to its heating powers, stated below, this invention will probably be found to be the most effectual yet introduced. In fact, the philosophical principles which govern the transmission of heat seem to be carried out to their fullest extent. The difference between the heating-box described in Fig. 48 and Mr. Walker's (Fig. 49) being, that in the former, the whole heating surfaces are surrounded by the heating medium; while in the latter, the outer surface only is heated, the heat being communicated to the internal perforations entirely by conduction,—the really original and valuable feature of the plan; few joints being required, and the danger of leakage being, to a considerable extent, obviated. It has been considered this plan would be "weak and slow in its operation". As a proof, however, that it really is not so, and further, as affording an instance of the valuable properties of heated iron as a conducting medium, the results of some experiments made to test its heating powers are here added.

With air in a natural state of quiescence, except only so far as it was set in motion by the heat of the iron:—A block, $6\frac{1}{2}$ inches square, 12 inches long, with 49 perforations, each $\frac{3}{4}$ of an inch square; the divisions $\frac{1}{8}$ of an inch thick; the outer shell $\frac{1}{4}$ of an inch thick; the temperature of water applied to the outer case, 200°; ditto of atmosphere, 56°.

1. The thermometer let down six inches into perforations—

In the corner (nearest the water, the heating medium) indicated	174°
In the centre	164°
Difference	10°

2. Bulb of thermometer level with top of block—

At the corner indicated	156°
At the centre	152°
Difference	4°

The difference showing that the conducting power of iron, heated by water at a distance from it, results in a temperature little less than that of the portion actually in contact with the heating medium. The difference, 6°, between the two experiments, was probably owing to the bulb in No. 2 being in contact with the iron.

A block, $4\frac{7}{8}$ inches square, 24 inches long, with 49 perforations, each $\frac{5}{8}$ of an inch square; the divisions $\frac{1}{8}$ of an inch thick; outer shell $\frac{1}{4}$ of an inch thick. Temperature of water 200°; atmosphere 50°.

3. The thermometer suspended in a wooden tube bulb twelve inches above block—

Over the corner indicated	135°
Over the centre	132°
Difference	3°

In this experiment, it will be observed, that though the heating surface was much increased, nearly in fact doubled, the temperature attained was not so high as in the two former cases; this may be attributed to the fact, that the bulb of the thermometer being close to the heated iron, and within the influence of radiation; whereas, in No. 3, it was purposely placed beyond it. Nevertheless, the result obtained is still decisive as to the fact that there is very little difference between the temperature of the iron heated by contact with the water, that being two inches from it, deriving its heat solely from conduction.

A block of the same external dimensions as that in No. 3, but having no perforations, constituting in fact a square pipe containing hot water. The temperature of water 190°, atmosphere, 64°.

4. The thermometer suspended in a wooden tube bulb twelve inches above the shell—

Over the side indicated	83°
Over the centre	76°
Difference	7°

Here it will be observed, that the air being more highly heated by the block in No. 3, than by the shell in No. 4, passed at a greater velocity, shewing that a much larger quantity of air was heated to a much higher temperature by the block than by the shell.

With air forcibly blown through the perforations by a four-horse power engine, working two double-action air-pumps, each six feet by five feet sectional area; the quantity of air passed being equal to 13,000 cubic feet, at a velocity of eight hundred feet per minute; — Fourteen heat boxes, each containing six perforated blocks, each having forty-nine perforations, the whole amount of heating surface, including that of cases, being 2,240 square feet; notwithstanding the great quantity of air passed, which was such as to lower the temperature of a hot chamber over the heat boxes from 212° to 180° (the former being the temperature when the engine was at rest), the difference between the centre and corner openings could at no time be found more than 10°. To the finger the central opening appeared in no way to differ from the corner one in point of temperature.

The rules for finding the area of hot-water pipes for any required size of apartment, are, in all respects, essentially the same as those given for steam; excepting in one point, that is, the mean temperature of the pipes. In the calculation for steam pipes, 200° is given; but 140° to 150° may be taken as that of low temperature hot-water pipes.

From the data obtained by Hood, it appears that water in a pipe of four inches diameter loses ·851 of a degree of heat per minute, when the excess of its temperature over that of the surrounding air is 125°; and also that, under the same condition, one foot of such a pipe will heat 222 cubic feet of air one degree in the same time: whence he deduces the following rule:—Multiply 125 by the difference between the maximum proposed temperature of the room and that of the external air, and divide this product by the difference between the temperature of the pipes and that proposed for the room: then the quotient is to be multiplied by the number of cubic feet of air to be warmed per minute; and the product divided by 222 will give the number of feet, in length of pipe of four inches in diameter, required to produce the same effect: this length is to be multiplied by 1·33 or by 2, for equivalent lengths of pipes respectively three and two inches in diameter.

These remarks are to be considered merely as elucidative of the principles and practice of heating as generally adopted; not as recommendatory of any particular plan. It is difficult to say whether the low water apparatus is not superior in work to any other, when properly fitted up by an engineer possessing a thorough knowledge of his subject. In deciding upon the form to be adopted, the architect will be guided by local and other circumstances; these will necessarily vary in different cases.

The admirable arrangement in Franklin's stove presents a feature of the utmost importance, viz., the consumption of smoke; and it clearly points out a means of accomplishing that desideratum. The obvious practical difficulty is the fire-grate: could any material be discovered which would resist the intense action of focal concentration of heat where the flame passes downwards, all the other conditions, of agreeable temperature, cheerful appearance of fire, sufficient ventilation, and perfect freedom from dirt or smoke, would be fulfilled. Were houses built with one central chimney, having an outer case carried up to the full height of this smoke-flue,—forming an air-shaft,—the flues from each stove could be conducted to the chimney, and each apartment could have a ventilating tube leading to the shaft, —the heat of the chimney maintaining a constant upward current therein,—there would be a certainty of warmth and ventilation to every apartment; and a city of such dwellings would possess an atmosphere free from a canopy of smoke with all its attendant disadvantages; in short, the economy and salubrity of the system would be incalculable.

Robert S. Burn.

Of the publications upon this subject, the following additional works, (see also Ventilation), may be mentioned:—

G. P. Boyce, *Remarks on the different systems of Warming and Ventilating Buildings*, 8vo, 1826; Alf. Beaumont, *Hints for preventing Damage by Fire in the Construction and Warming of Buildings*, 8vo, London, 1835; C. Sylvester, *The Philosophy of Domestic Economy, as exemplified in the mode of Warming, Ventilating*, etc., 4to, Nottingham, 1819; W. Walker, *On the comparative merits of the various systems of Warming Buildings by means of Hot Water*, 1837; H. W. Dewhurst, *Practical Observations on Warming Dwelling Houses and Public Buildings with Hot Water*, 12mo, London, 1832; C. Hood, *A Practical Treatise on Warming Buildings by Hot Water; on Ventilation*, etc., third edition, 8vo, London, 1850; Col. W. Cook, *On Warming Rooms by Steam conveyed in Pipes, Phil. Trans.* 1745, p. 370; Robertson Buchanan, *Essay on the Warming of Mills and other Buildings by Steam*, 1807; Trans. Soc. Arts, 1806, etc.,; A. M. Perkins, *Improved Patent Apparatus for Warming and Ventilating Buildings*, 12mo, London, 1840; J. Davies and G. V. Ryder, *On the system of Warming Buildings by Hot Water, a Reply to* Mr. Perkins's *Answer to the Report presented to the Manchester Assurance Company*, 8vo, Manchester, 1841.

HIP-KNOB.

PLATE XC.

The term Gable, Hip, or Ridge-knob, signifies a pinnacle, finial, or other ornament, placed on the top of the hips and ridges of roofs, or on the point of a gable. Crosses have been usually fixed in those situations on ecclesiastical edifices, but on other buildings ornaments of various kinds were used; and when applied to gables with barge-boards, the lower part of the hip-knob frequently terminated in a pendant. The architectural forms given to the cross as a hip-knob, scarcely differed from those which it presents in every collection of its shapes; and therefore attention will only be given, in the present instance, to those finials of other forms.

The subject has hitherto met with little attention in England, but in France it has been ably treated. The following observations have been extracted from the work by E. de la Quérière, quoted in the article Ridge, in which a preference is given to examples whose epoch could be ascertained with certainty, either from the date marked upon the fronts of the houses, or from the character of the architecture and ornamentation.

It is supposed that the word "épi" arose from the similarity existing between the ornaments so called, and ears of corn (épis de blé); nevertheless, it seems that the origin of épi, espi, would be more correctly given as espié, espiel, espiet, espièu, *i.e.* épée, etc., and in general anything pointed, from spina, as is found in the *Glossaire de la Langue Romane* of Roquefort. That the term "espi" was used in the fifteenth century, is proved by a manuscript (*Comptes de la fabrique de la paroisse Saint Laurent de Rouen*, suppressed in 1791, for the year 1470-1471), in the archives of the Departement de la Seine Inférieure, in the depôt of the ancient library of the cathedral of Rouen, which says: "A Cardinot le Pelletier, pour cent liures de plomb, n'est pas comprinse la peine et salaire de la fachon des cinq *espis* des chapelles du hault de l'esglise tant de costé que d'aultre commenchés à faire et mesme du plomb."

Although at Caudebec-en-Caux there is a stone house of the thirteenth century, exhibiting upon its gable a contemporary capital, which probably bore a statue or some such object, there are no sufficiently authenticated examples of hip-knobs earlier than the fifteenth century; which is the more remarkable, as Vanes (in themselves a branch of the present subject) and hip-knobs were marks of distinction appropriated to the châteaux and hôtels of feudal times: and although all the civil and religious edifices of any importance of the fifteenth and sixteenth centuries, and of a great part of the seventeenth, were ornamented with crests and hip-knobs, and had the leadwork of their ridges glistening with gilding and painting. In the Departement du Cher, the Château de Meillant offers an extremely rare example of the complete decoration of an ancient roof (Ridge, Plate 81, Fig. 9): this and the specimens at Abbeville; and also those on the apse of Evreux cathedral; those of the cathedral, of the arcade of the Grosse Horloge, of the Palais de Justice, and of the tower of S. Romain at Rouen, are all mentioned on the second page of the description to Plate 81, Ridge, as well as a drawing of such a careful termination of a roof, which was designed in the time of Francis I, for the church of S. Vincent at Rouen.

At Alençon, near the church, in the place Notre-Dame, is a house of the sixteenth century, having two vanes and a hip-knob in the style of the Renaissance. At Argentan, in the rue des Capucins, there are some fine complete hip-knobs of the seventeenth century, with some others which are very remarkable: in the place de la Cathédral at Auxerre, there remains a curious fragment of a hip-knob of the fifteenth century, at the top of a turret belonging to a private house; also a hip-knob of the seventeenth century on a house in the rue des Lombards: those of the old Hôtel Dieu at Beaune may be mentioned; also those of a house at Caen of the sixteenth century, in the rue du Moulin, at the bottom of a large court. At Dijon are the vanes of the Hôtel de Mimeure and the hip-knob of the Hôtel Chambellan, and at Delft are two peculiar hip-knobs. On the château at Eu there are four hip-knobs of the sixteenth century, and four others of the seventeenth. At Gien are those of the château, of the time of Louis XII: at Lisieux some mutilated hip-knobs, among others that of the house in the rue aux Fèvres: at Mans, that of a turret, which is near the south portal of the cathedral. At Paris some are remaining in the Place Royale and some at the Préfecture de Police, all of the time of Louis XIII; at Reims are those of the Hôtel-de-Ville; and at Troyes the vanes of the old Hôtel de Vauluisant, built at the epoch of the Renaissance; one of these represents the sun, the other is the crescent moon surrounded with stars; both the stems are very high, and ornamentd with dolphins, etc.: another charming vane of the same epoch, about fourteen feet high, attracts notice at the foot of the rue de la Monnaie, facing the rue des Croisettes. At Vitré are the hip-knobs of the

castle, and Verneuil possesses the remains of a hip-knob of the end of the fifteenth century, upon a turret, corbelled out from the angle of an important and very remarkable house in the rue de la Madeleine.

There are three ornamental vanes at Epernay, besides other vanes and hip-knobs remaining in divers places in Britany; at Quimper-Corantin; Brest; on the hospital at Landernau; and on the châteaux of Brignon, of Kéroel or Kérouel, and Tréséol; the vanes of this last bear the date of 1642. In the hip-knob with the vane observable at the town of Brest, anchors are employed. According to M. Ch. Grouet, very curious vanes of the sixteenth centnry are to be seen at Grange-le-Roi (Seine and Marne), at the château of the celebrated Fouquet, built in the seventeenth century and situated at Vaux-le-Praslin; also at Dôle (Jura) and at Gray (Haute-Saône).

This enumeration is poor in comparison with the numerous examples that Rouen is able, nothwithstanding its daily losses, to offer to the curiosity of strangers, particularly if the types belonging to the latter half of the seventeenth century are included, which still present themselves in large numbers.

It may here be mentioned that the artists of that period always reproduced in lead, what was done in stone, according to the types of ornamentation of the period. In point. of fact, however, the hip-knobs of the fifteenth century have become so extremely rare, that even Rouen offers no more than five examples. These consist of two fragments, one on the houses No. 112-114, rue Martainville, and No. 23, rue de la Grosse Horloge, or Grande Rue, Fig. 7 (as restored by La Quérière); the base of this last very much resembles that shown, Fig. 5 of Plate 81, Ridge; and another of this description, very well preserved, remains on the ridge of the chapel of the Virgin at Evreux cathedral, and another upon the church de la Madeleine, at Verneuil (Eure): two others are to be seen, the first upon the chapel of the hospice at Orbec (Calvados), the second at Paris, in the cul-de-sac des Bourdonnais; the latter is terminated by a bouquet of lilies. The hip-knob upon a turret in the rue de la Madeleine at Verneuil, is of a different type to the above; and upon the chapel called des Machabées, adjoining to the cathedral of Amiens, is one of the same century deserving of notice. There are some perfect and extremely remarkable examples (Fig. 9) at the chateau de Martainville-sur-Ry, near Rouen. The other specimens at Rouen comprise one (Fig. 8), mutilated but analogous to no other known example, springing from the top of one of the turrets of the archbishop's palace in the rue S. Romain, facing the rue des Chanoines; it has a very high stalk, bearing four rays sculptured into foliage, the termination of which could not be ascertained: a wooden turret of the fifteenth century, enclosing the staircase of the house, No. 17, rue Bouvreuil, and covered by a high pitched roof, surmounted by a very dilapidated vane; and lastly, the turret aux Pastorales of the Hôtel du Bourgtheroulde, furnishes a remarkable example of the ornamentation of the hip-knobs of the end of the fifteenth century, Fig. 3. The crowning of the hexagonal slate roof is enveloped with a network of lead, bearing foliage on the hips. From the summit of this point springs a high iron stalk, bearing a large thistle flower (which, like the lily, was very common at that time), around this other thistles were grouped, now reduced to a very small number. At Verneuil, the turret corbelled out from the fine stone house of the time of Louis XII, at the angle of the rue du Pont-aux-Chèvres, has a bouquet composed of four lilies, surmounted by a vane, also having a lily at its summit, the whole in ironwork.

At Rouen are several buildings of the fifteenth century with overhanging stories, having above their gables the rudiments of hip-knobs no longer in existence. Such are the houses in the rue Grand-Pont, No. 60-62, at the angle of the rue de la Madeleine; rue du Bac, No. 66, at the angle of the rue des Fourchettes; rue des Charettes, No. 20, facing the rue de la Comédie; and the house formerly called "Caradas", from the name of the proprietors, an important and curious construction, with two stories, occupying all one side of the rue de la Tuile to the rue de la Savonnerie. This house is engraved in vol. ii of the author's *Description Historique des Maisons de Rouen*, etc.

The epoch of the Renaissance is the most fruitful in fine and elegant hip-knobs of every description; it was also the time when good taste was invariably shown. Upon a base, mostly square, with more height than breadth, with mouldings, ornamented on its faces with little grotesque heads or tablets, is placed a candelabrum, an elegant vase, a flower-basket, or an urn, of a light and graceful form, and springing from which are leaves, flowers, and fruits. This base likewise sometimes supports small figures.

The different pieces which compose the épi or hip-knob, fitted one above the other, are held together by an iron rod, which passes through them and comprises the basis; this at its lower extremity divides into four branches, to clasp, if the expression may be used, the post upon which the entire hip-knob is fixed. This piece of wood called an "épi," has probably given its name to the ornaments with which it is finished. The height of the best hip-knobs of private houses varies from three to six feet, but there are some, principally with vanes, which are as much as from twelve to fifteen feet.

Two of the four hip-knobs, which existed upon a house in the rue des Charettes, Nos. 100-102, have been measured and weighed. They are each four feet four inches in height. The weight of an iron stalk of this length is sixteen pounds; and that of the lead of a hip-knob is from eighty-five to ninety pounds. So that the total weight of each hip-knob is a little less than one hundred and six pounds.

In places where potteries existed, crests and hip-knobs were made of burnt clay, also ornamental ridge-tiles (in the neighbourhood of Etampes, ridge-tiles have been discovered surmounted by a trefoil). Hip-knobs of burnt clay, perfectly executed and greatly resembling lead, have been seen in different localities, especially in Lower Normandy, at Alençon, Bayeux, Coutances; above all at Falaise (two hip-knobs of the Renaissance upon the Prefecture, rue Basse), and at Domfront, upon the Maison-du-Juge-de-paix, of the same period, and upon other houses.

After searching among a number of collections of drawings and engravings for examples, the author was only able to find two sheets, each containing four designs for hip-knobs of the end of the Renaissance and of the sixteenth century. These form part of a volume of manuscript designs by Jacques Androuet-Ducereeau, deposited in the Bibliothèque de Sainte Geneviève at Paris.

Fables, allegory, mythology, social life, and religion, have furnished numerous subjects, both various and graceful, for the finishing of the coverings of roofs. Thus a little soldier, armed from head to foot, is to be seen at Rouen upon a house of the Renaissance, rue Saint Denis, No. 38. A sort of bully, with a drawn sword, still figures over a window at the house, No. 11, rue Herbière; likewise some little Cupids, with quiver on shoulder and bow in hand, shoot very innocent arrows from above lucarnes (from whence they have seen three hundred years), in rue du Bac, No. 40, seemingly at one of their brethren, still remaining in the place du Vieux-Marché, at the corner of the rue du Vieux-Palais. Another infant, also drawing a bow, belonged to the house rue Ecuyère, No. 44; but an amateur having by chance spied it out, roosting on its lucarne, had it taken down to ornament his country house. It would appear that this *motif* is often copied at Rouen, for at Dieppedalle, three miles from the town, upon a house with a steep roof, there are two little naked figures, one of a child drawing a bow, the other of Neptune.

Lastly, Justice, Strength, Hebe, Temperance, and Prudence, statues as large as life, the first and last executed in a very remarkable manner, complete, with magnificent hip-knobs, the

picturesque appearance of the Château d'Angerville-Bailleul, built in the year 1543, and situated in the Pays de Caux, in the canton of Goderville (Seine-Inférieure).

Statues and hip-knobs also figure upon religious edifices. At the cathedral of Rouen, the chapel of the Virgin still shows, upon the hip-roof of its apse, a fine statue of the mother of the Saviour, and a magnificent hip-knob of the sixteenth century (Fig. 10). At the church of Saint-Ouen, was formerly an angel, such as still remains at Rheims, over the choir of the cathedral; and at the cathedral of Toul, near the enclosure (*Lanternon*) of the clock. At Falaise, the chapels at the north of the nave of the church of the Trinity, are surmounted by a leaden figure, and each figure is in a different attitude. At L'Aigle, at the summit of the high-pitched slate roof of the bell-tower of the principal church, between two badly-executed colossal statues of angels in lead, rises a hip-knob, composed of several tiers of lilies overlaying each other; the whole surmounted by an eagle, in allusion to the name of the town. On the south aisle of the same church, is a hip-knob formed of lilies. Fine ones are to be seen at the cathedrals of Amiens and Rouen, the church at Aumale, etc. There still remain a few scattered over the turrets of some of the old châteaux. As to those of city habitations, they have been almost all annihilated.

The most curious hip-knobs of the sixteenth century now remaining at Rouen, are those with vanes, on a building at the bottom of the court-yard of the house No. 6, rue Herbière (Fig. 4). That which is seen at the top of the staircase of the house, externally decorated with arabesques, in the rue de l'Hôpital, No. 1, nearly resembles Fig. 5; those, originally four in number, but now reduced to two, in the rue des Charettes, No. 100-102 (Fig. 5), upon a stone house dated 1587, destined to be removed for the indispensable enlargement of this street. Those which are seen at the old Hôtel de Senneville, No. 30, rue Damiette; rue Bouvreuil, No. 24-26, over a building at the bottom of a court; rue de l'Ecureuil, No. 14; rue de la Grosse Horloge, No. 159; and rue du Coquet, No. 5. There still remain other very pretty hip-knobs of this epoch, which must be passed over, though they have become rare. But the leaden swan crowning the house numbered 12, 14, and 16, rue de la Cicogne, must not be omitted; it was certainly repeated as a sign in a more conspicuous place, and gave its name to the street.

As types for the end of the sixteenth century, and the commencement of the seventeenth, the hip-knobs of the large stone house, rue des Carmes, No. 66-77, at the corner of the rue Saint-Lô (Fig. 6) may be given as representations. A head of a bearded man, in profile, of good execution, adorns the return of the square of this house at the rue Saint-Lô. Unfortunately, almost all the sculptures upon the side of this house have disappeared under pretence of embellishment.

Attention is directed to the hip-knobs of the period of Henry IV, which decorate a remarkable stone house, bearing the date 1601, Grand Rue, No. 101-103; and another house, rue Saint Hilaire, No. 130. This is almost all that is known here of this sort, a fashion which arose in the midst of the traditions of the Renaissance, traditions which have been followed to a recent time, as is proved by the hip-knobs of the rue du Renard, No. 59; and those of the rue Bouvreuil, Nos. 24, 26 (Fig. 14.)

Under Louis XIII, the form of the hip-knobs was affected by the heavy style into which the arts dependent upon design had fallen. The bases, formerly imitated from the antique, take a distorted form. Vases, often of a not very graceful outline, with or without handles, are still employed; but frequently the base of the hip-knob bears a ball surrounded with foliage, and surmounted with a stalk more or less ornamented.

Fine examples of this description are to be seen at the house called the "Swan", dated 1631, in the rue Cauchoise, No. 47, (Fig. 2); rue des Charettes, No. 83, at the corner of the rue Haranguerie, dated 1640 (Fig. 1); rue des Carmes, No. 80, at the corner of the rue de la Chaîne; again at No. 15; rue Saint-Patrice, No. 36, facing the rue Etoupée; place de la Pucelle d'Orleans, No. 12; rue Saint-Georges, Nos. 5-7; rue aux Ours, No. 69; also at No. 45: the latter showing a blooming bouquet; rue des Cordeliers, No. 29; rue des Vergetiers, No. 17; rue Ganterie, No. 104; rue des Bons Enfants, Nos. 41-43; rue Boutard, No. 21, etc. Lastly, at the main building at the bottom of the court of the beautiful timbered house in the rue de la Grosse-Horloge, No. 115: the latter (Fig. 11), which are very curious, have figures of children placed round the base of a large vase (*cassolette*). Also may be mentioned the three large hip-knobs of the house No. 17, rue Herbière (RIDGE, Plate 81, Fig. 2).

In the second half of the seventeenth century, under the minority of Louis XIV, the hip-knobs still more degenerated; some are, however, to be found, remarkable for their originality, such as that (Fig. 12) of the house No. 95, rue de la Vicomté, formerly du Merrier, dated 1643. From that time they are generally a quadrangular pyramid, accompanied by four handles in bad taste, and terminated by a sort of cabbage. Frequently these hip-knobs, employed with lucarnes, are short and stunted, like those are on the houses in the rue Saint Antoine, near the Marché-Neuf; or those of the houses built in 1663 for the old monks of Saint Lô and occupying all the side of the rue de Socrate (before the Revolution, rue Neuve Saint Lô); or those still on the house rue des Fossés-Louis VIII, No. 28, bearing the date of 1666.

The description of hip-knob (Fig. 13), of which numerous examples present themselves in town and country, offers a variety known by a species of plume, like those of the rue de la Vicomté, just mentioned.

Nevertheless, art sustained itself to the end of the reign of Louis XIV. The proof thereof is seen in the hip-knobs of a house situated in the faubourg d'Eauplet, No. 63 (RIDGE, Plate 81, Fig. 3), built about 1680; and the hip-knob, consisting of a heart pierced with arrows in saltire, and crowned with flowers, to be seen on the roof of the ancient convent of the barefooted Augustines, founded in 1674, in the place du Champ de Mars. But at the accession of Louis XV, this kind of ornament clearly showed that it had had its day. During the greater part of the eighteenth century, it was nothing more than a pedestal, upon which was mounted a very simple urn (abbey Fécamp), or a reversed pear (Hôtel de Ville at Rouen, formerly the dormitory of the monks of St. Ouen; the presbytery of the parish church of Saint Vincent; the house No. 61, rue du Renard, etc. etc.); or a ball accompanied by a few leaves (quay du Mont Riboudet, No. 44), which at last altogether disappeared, only to leave a plain ball upon a pedestal. This ball or little globe, now almost always made of tin or zinc, gilt in some districts, is sometimes borne by a little quadrangular pyramid of the same metal, instead of lead, the material always used in former times.

To complete this portion of the subject, it may be useful to add LA QUÉRIÈRE's remarks upon the *girouette* or vane, which probably ought always to have surmounted the *épi* or hip-knob. As the embattlements and turrets which served for the defence of the châteaux showed nobility, so only gentlemen had the privilege of adorning the ridges of their houses with vanes, which were pointed like pennons for simple chevaliers, and square like banners for the knights bannerets. (LA CURNE DE SAINTE PALAYE, *Mémoires sur l'Ancienne Chevalerie*, Paris, 1826, vol. i, p. 26.

According to RENAULDONT (*Dictionnaire des Fiefs et des Droits Seigneuriaux*, etc., 4to, Paris, 1745), there were two kinds of vanes, simple and square. The nobles and proprietors of a fief might place simple vanes on their houses and dovecots; but he thought that the tenant had not this right, because it was a mark of the nobility of the person or estate. With respect to square vanes, as they were seigneurial marks, the lord might prevent the vassal and tenant from using them, as was judged

by a decree of the parliament of Bourdeaux, recited by Lapeyrère.

On this subject, the entrance gate of the ancient Charter House of Val-Dieu, near Mortagne (Orne) may be cited; it is a portal built in the eighteenth century, where there are two square vanes, bearing the arms of Rotrou, its first founders; they are made of iron, cut in open work. Very few of the vanes now remaining have preserved the primitive character of the middle ages, for only those just mentioned were known to La Quérière.

"On the turrets of the southern châteaux," says Marchangy (*Gaule Poëtique*, 4th edit., vol. iii, pp. 99, 100), "we see vanes in the form of cocks. The right of placing vanes upon a château," continues the same author, "only belonged, in the commencement, to those who were the first to mount in an assault, and who had planted their banner upon the rampart of an enemy: therefore they gave to these vanes the shape of a flag, and painted on them the arms of the master of the place."

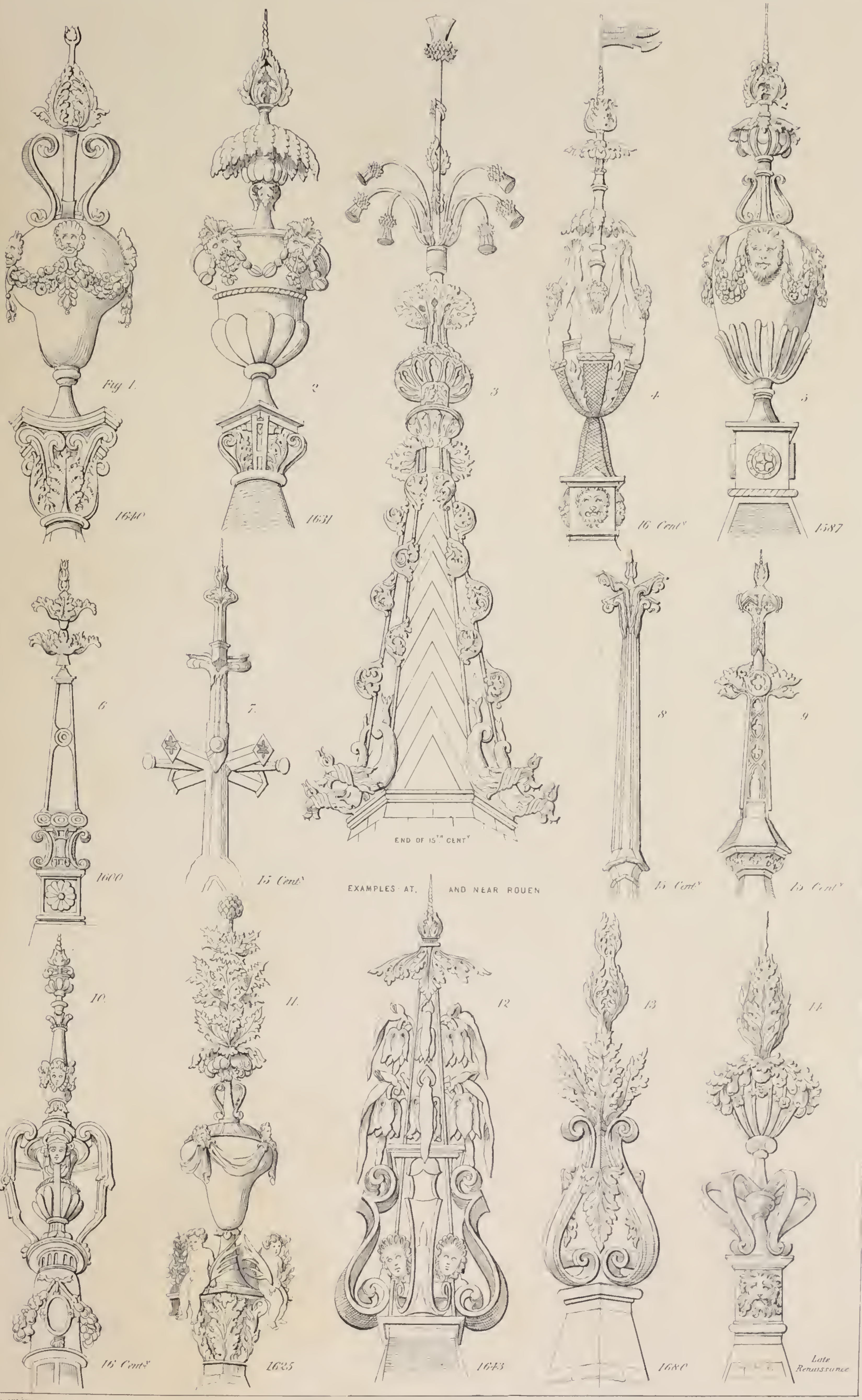
The most conspicuous modern vanes are composed of a rod of iron, crossed at right-angles by two others, much shorter, at the extremities of which are indicated the four cardinal points, by the Roman initial letters N., S., E., W., gilt. The vane properly so called, of wrought iron or "*tole*", *i.e.* tin-plate, placed above, consists of the union of several gilt arrows, usually three, turning on the axis of the stalk; sometimes even a single arrow is sufficient. Other vanes show different fanciful subjects; sometimes an animal, a figure of Fame, a hunter, the sun, moon, etc. etc. In the seventeenth century, and during the eighteenth, an open-mouthed head was commonly employed.

In some localities (among others, at Troyes), there is a special elegance in the fabrication of modern vanes and hip-knobs. The stalks are ornamented with little globes, pierced; with balls armed with points, forming stars; with crescents, etc. etc.

Hip-knobs have disappeared, through time and other causes; among these, are the ignorance and carelessness of proprietors, and the unskilfulness or bad intentions of plumbers. It is thus that throughout France, the greater number of old houses, public buildings, and even churches, have successively been despoiled of the ornaments which crowned their summits.

A. W. MORANT.

HIPKNOB.



E. de la Querière

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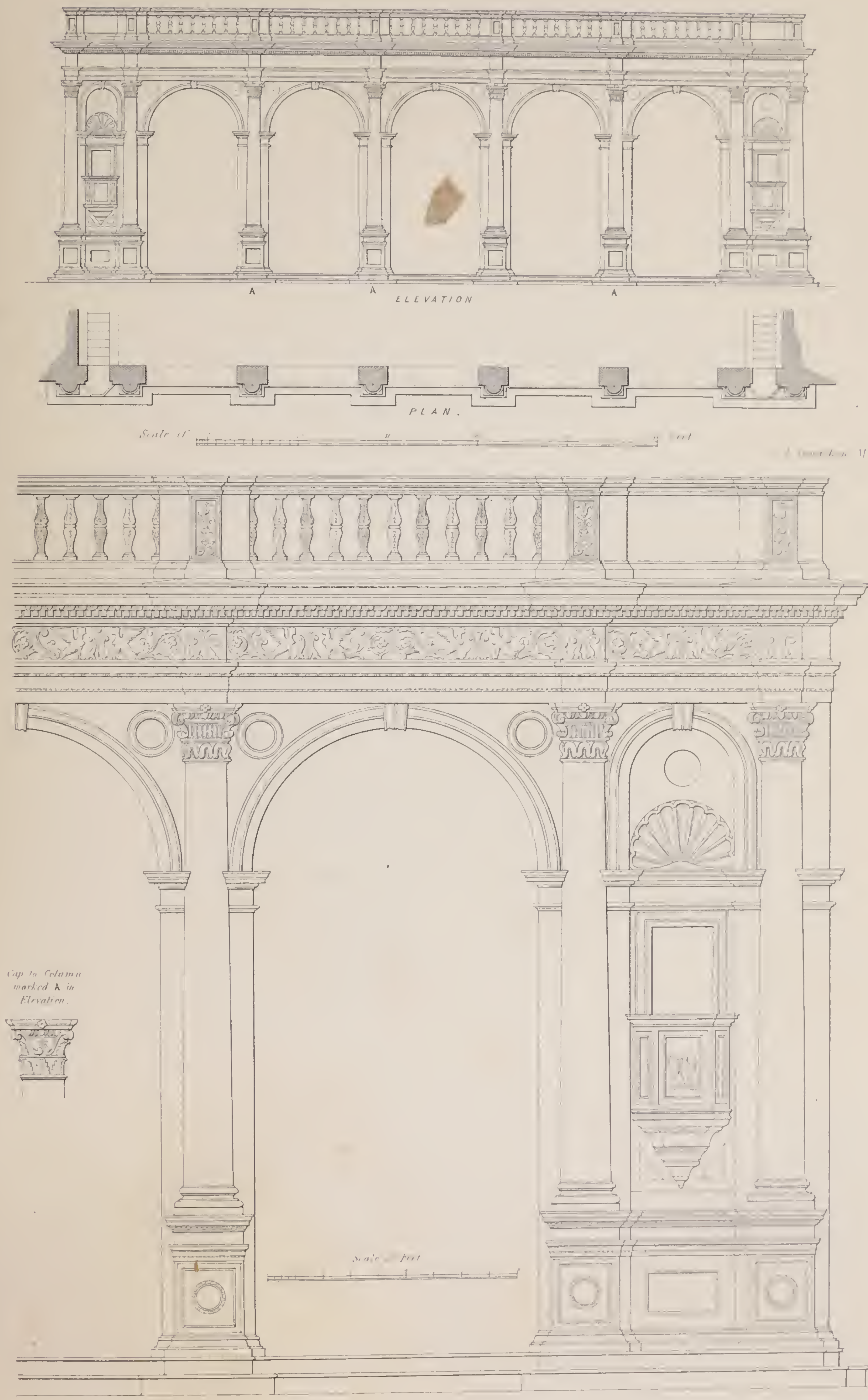
LOGGIA



SPOLETO.
CATHEDRAL.
Bramante Archt

LOGGIA

LOWER LOGGIA, LORETO.

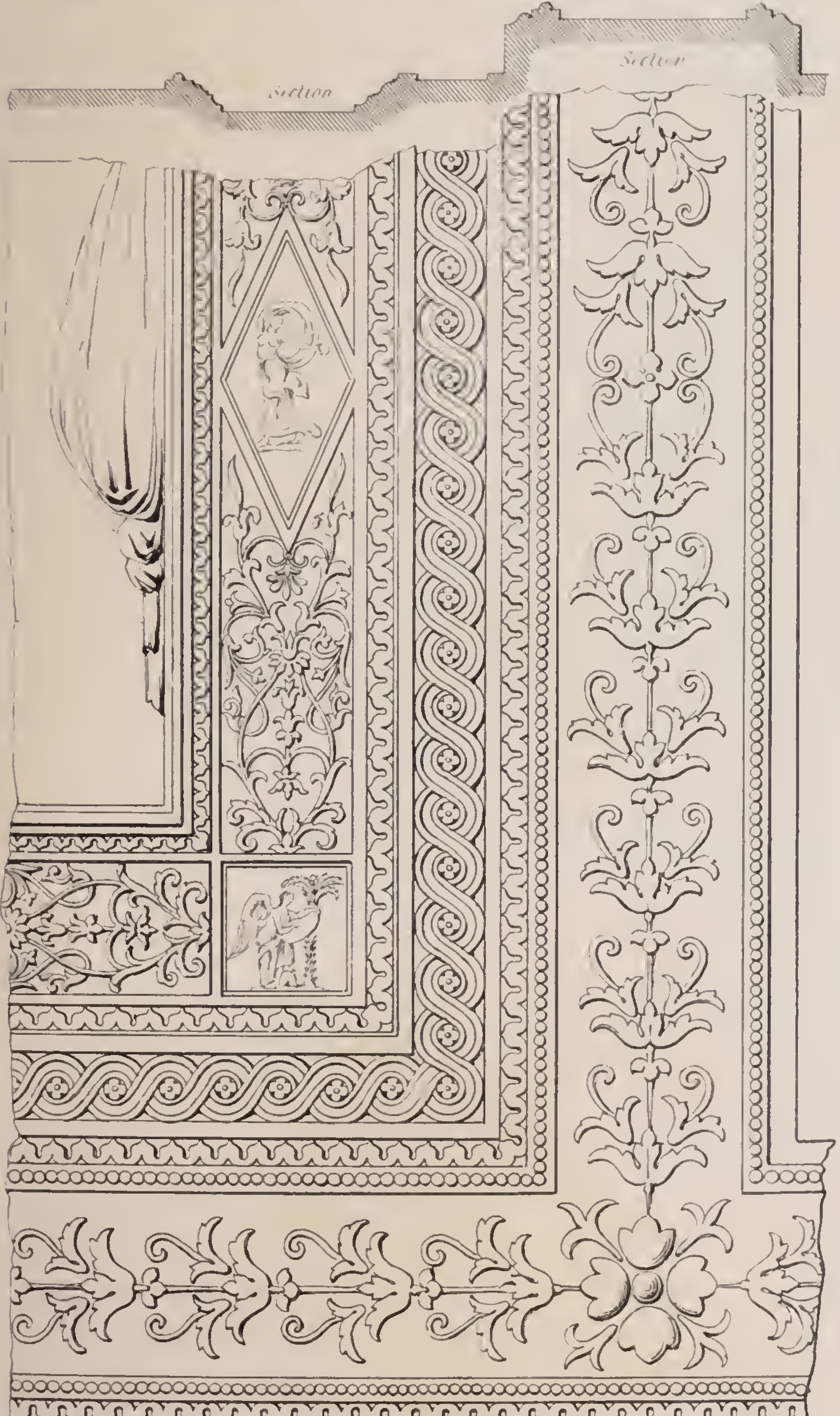
Lithographed by Vincent Brooks & Son ... Jan. 26th 1850

LOGGIA.

Fig. 1

LONGITUDINAL SECTION ON LINE A.B.

Scale to Fig. 1 & 2



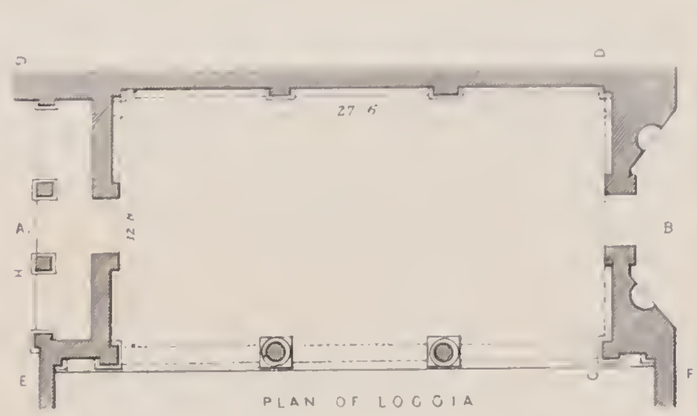
PART OF PANEL IN CIELING

The white figures and gilt enrichments are executed in raised Stucco

1/8 Real Size

Fig. 2

TRANSVERSE SECTION
LINE C.D.



PLAN OF LOGGIA

Scale to Plan

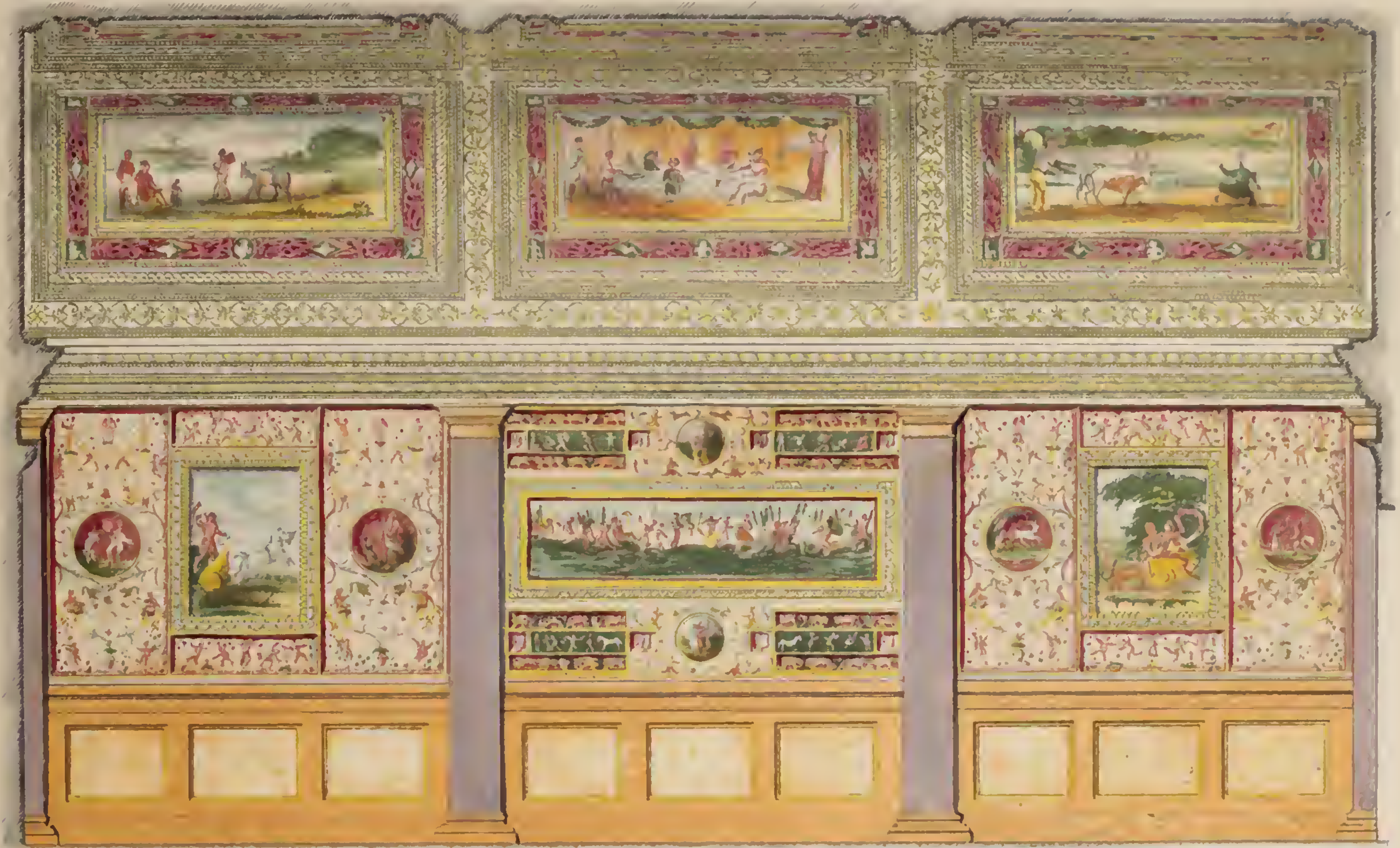
LOGGIA OF THE GROTTO.

PALAZZO DEL TÈ _ MANTUA.

R. W. Hensker, M. I. B. A.

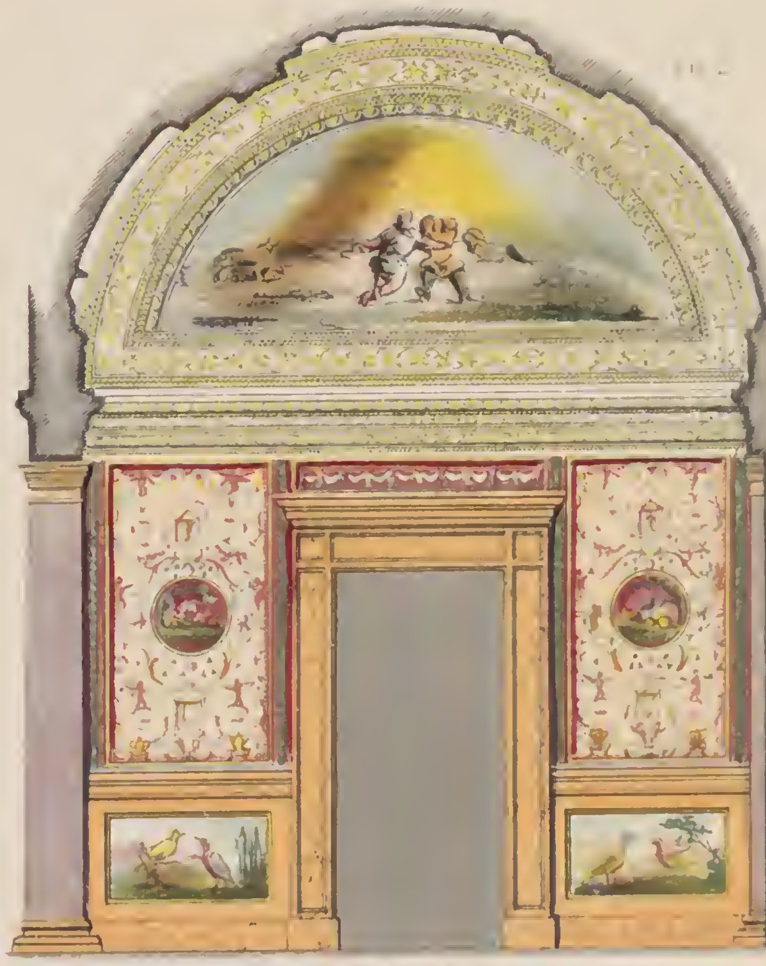
LOGGIA

Fig 1

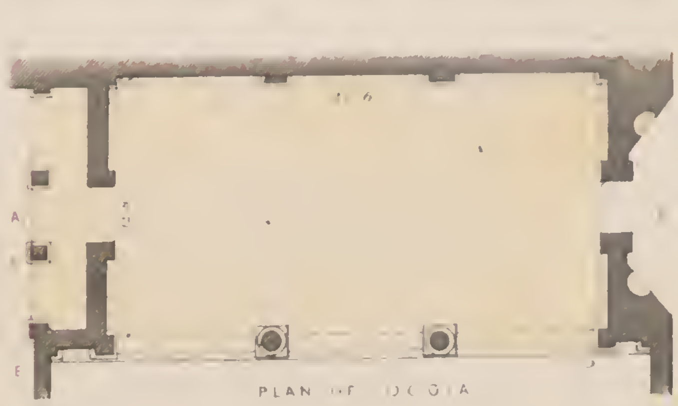


SECTION ON LINE A B

PART OF PANEL IN CEILING



TRANSVERSE SECTION



PLAN OF LOGGIA

Scale to Plan

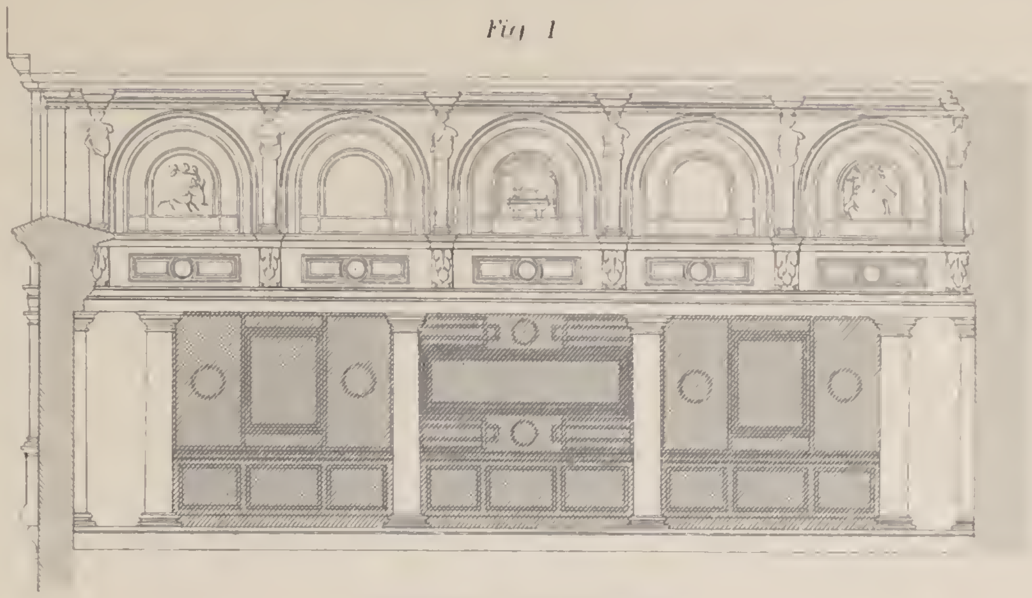
LOGGIA OF THE GROTTO

PALAZZO DEL TE MANTUA

W. Hensker M.I.B.A.

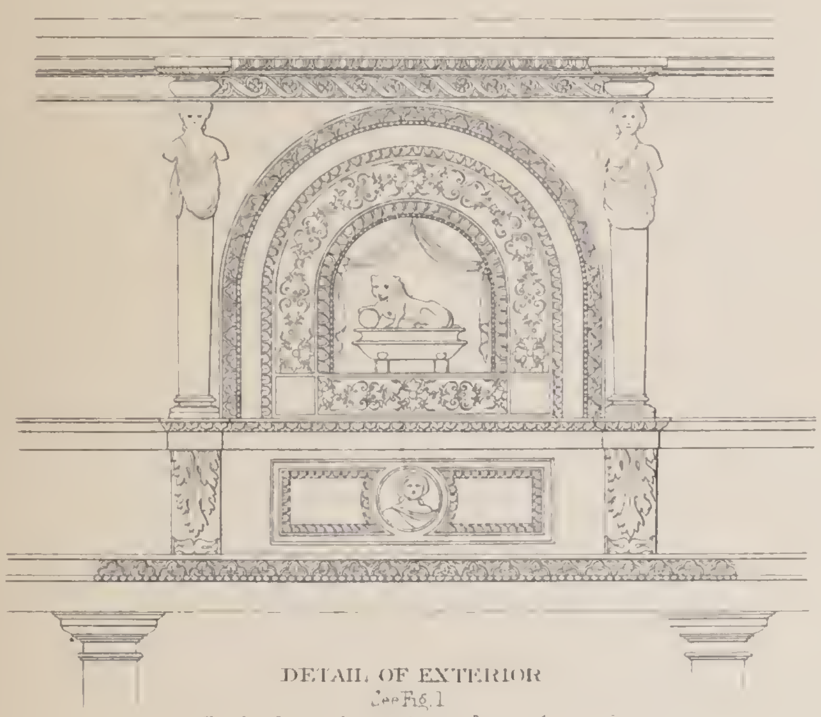
LOGGIA.

Fig. 1



EXTERIOR ELEVATION
Line E. F.
SCALE OF FEET

Fig. 2.



DETAIL OF EXTERIOR
See Fig. 1
SCALE OF FEET

Fig. 3

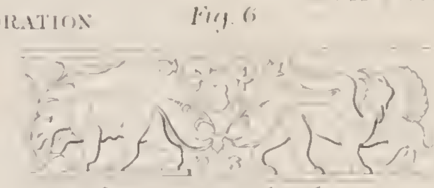
END ELEVATION
Line G H
SCALE OF FEET

DETAILS OF INTERIOR DECORATION
See Fig. 1 Pl. 60
(About ½ Real size)

Fig. 4

In centre compartment.

Fig. 6

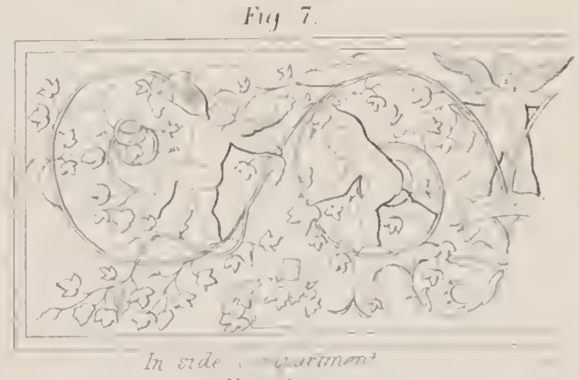


In centre compartment

Fig. 5.

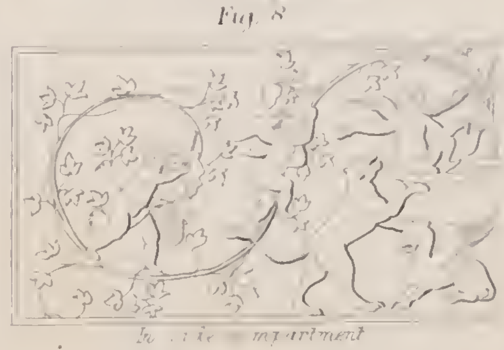
In centre compartment.

Fig. 7.



In side compartment

Fig. 8



In side compartment

GARDEN LOGGIA
PALAZZO DEL TÈ — MANTUA

L. Gruner.

Lithographed by [illegible]

MAUSOLEUM

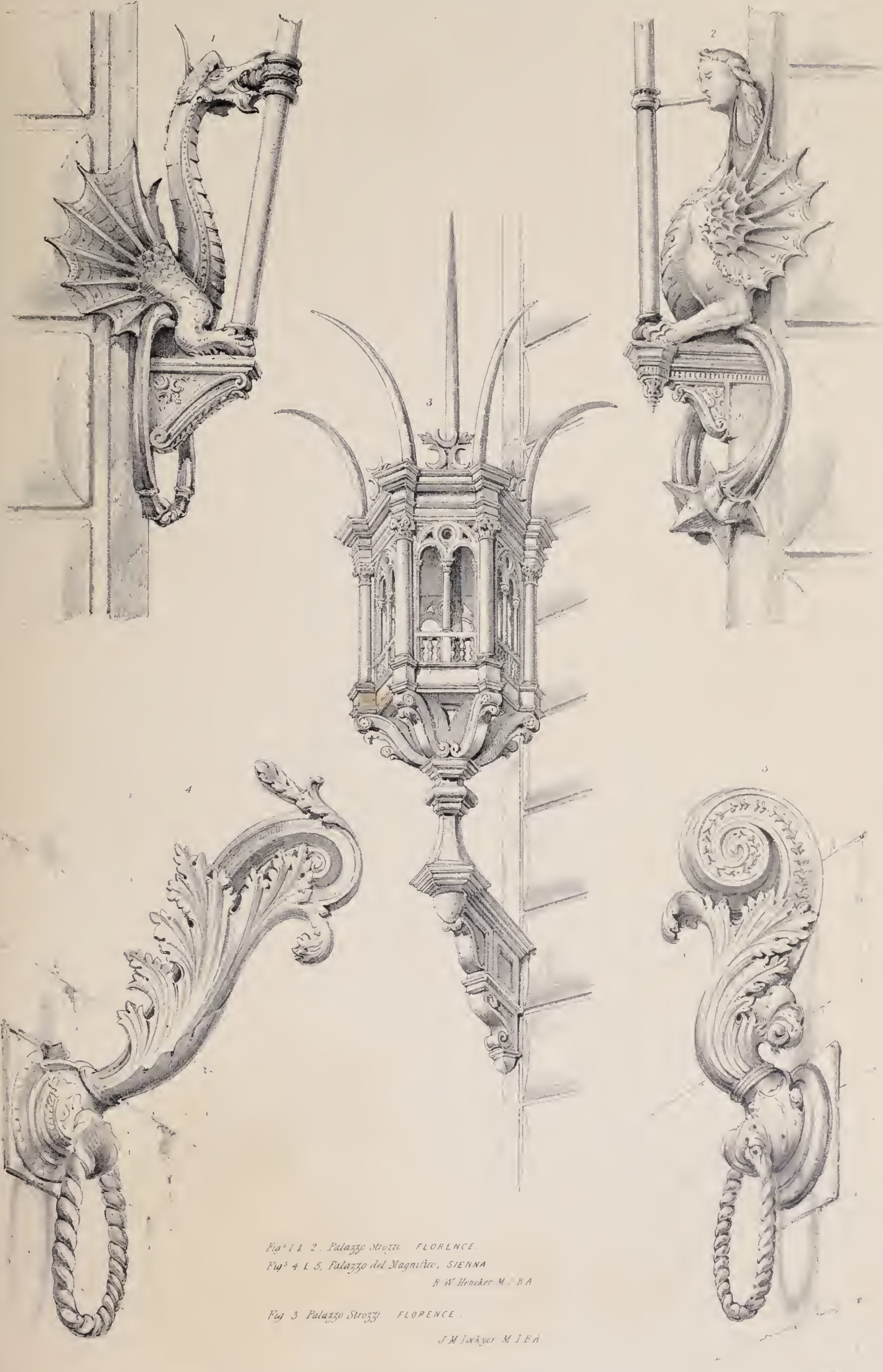
E. Falkener.

TOORBAH EL SULTAN MARTESSEB, CAIRO

March 1st 1845

Lithographed by Messrs Day & Son

METAL WORK



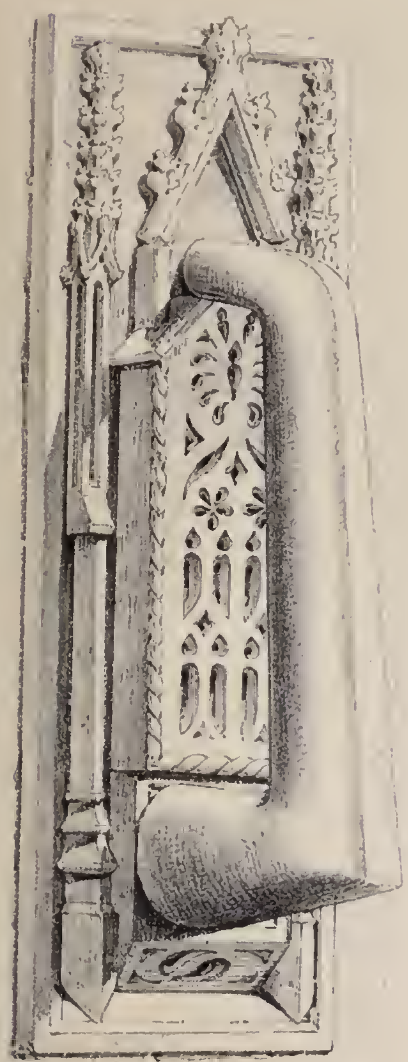
Figs. 1 & 2. Palazzo Strozzi, FLORENCE.
Figs. 4 & 5. Palazzo del Magnifico, SIENNA
R. W. Henekér M. I. B. A.

Fig. 3. Palazzo Strozzi, FLORENCE.
J. M. Lockyer M. I. B. A.

Lithographed by Messrs. Day & Son. May 7th 1849

METAL WORK.

Fig 1



NISMES.

2

NISMES.

3

NISMES.

4

CATHEDRAL _ BERNE.
TOP OF TOWER.

5

BERNE.

James Bell M I B A

Lithographed by Mc. . [illegible] Hay & Son, April 10th 1856

METAL WORK


GHENT
OUDENARDE
Arrangement of A
A
OUDENARDE
ANTWERP
MONS
MONS
OUDENARDE
GHENT
GHENT
BRUSSELS
MONS
GHENT
GHENT
GHENT
TOURNAI
BASLE
BRUSSELS
GHENT
St GUDULE BRUSSELS
St GUDULE BRUSSELS
J. B. Waring M.I.B.A.

NORDEN.

THE SURVEYOR'S DIALOGUE.

JOHN NORDEN seems, according to WOOD *(Ath. Oxon.* i, 450), to have had birth in Wiltshire, about 1548. Admitted of Hart Hall in 1564, five years afterwards he became B.A., and proceeded A.M. in 1573. It was probably during his residence, that he drew with the pen, on sixteen sheets, that map of all the battles, fought in England, from the Conquest to the time of Queen Elizabeth, which is mentioned by HEARNE *(Letter on Antiq. etc.*, p. 34), as formerly existing in the picture-gallery at Oxford. WOOD ascribes to him fifteen devotional pieces, now very scarce, (among which, *The Labyrinth of Man's Life* has a true poetic style), though he doubts if any were really written by him; and GRANGER *(Biog. Hist.)*, who describes a print of his portrait, attributes them to his father; but surely without sufficient grounds. He is the inventor of *An intended Guide for English Travellers*, 4to. Lond., 1625, the now common tabular form of calculation of distances, "showing how far one citie, and many shire towns in England are distant from each other". This was reprinted anonymously, 4to. Lond. 1643, and was the basis of many other publications, differing in little else but the title-page.

He was best known as a topographer, from the publication, 4to. Lond. 1728, of his *Survey and Map of Cornwall;* made probably in 1584, and perhaps printed from the Harleian MS. 6252, which contains coloured drawings of all the plates except the front of S. Germain's church. In the close of this document, which is addressed to King James I, the author observes: "Might it stand with your Majesty's good opinion and favour to enable me to proceed in the residue of your Majesty's kingdom (being by my former travailes, and by tedious attendance for my promised recompense, meerly undone), such shall be my loyal care and faithful diligence, as nothing shall be omitted worthy your Majesty's and his Highness' understanding, by Divine assistance, without which all endeavours are vain.—Debentur pigro præmia nulla viro."

This work was part of a projected historical and chorographical description of England, under the title of *Speculum Britanniæ;* but all that later appeared were the following divisions:—*Middlesex*, 4to. Lond., 1593, reprinted 1637, dedicated to Queen Elizabeth. In a prefatory letter to Burleigh, he speaks of long sickness and other impediments. It contains excellent plans of London and Westminster, engraved by Peter van den Keere. In 1596, he found it desirable to write a "preparation to this work, intended as a reconciliation of sundry propositions, by divers persons tendered, concerning the same." This is affixed to the second (third?) edition, 4to. Lond., 1723. The copy of his *Middlesex*, in the Harleian MS. 570, supposed to be in his own handwriting, differs from the printed copies, both in the arrangement and the additions made to it. *Hertfordshire*, also 4to. Lond. 1593, 1605, 1637, and 1723. In the prefatory letter to Burleigh the author says, "I have been forced to struggle with want, the unpleasant companion of illustrious desires, and have long sustained foils, enforced neglect of my purposed business and sorrow of my working business,—Miseria mentem macerat." *Northamptonshire*, "done after this poor sort, being otherwise employed in surveys there," in 1610. This was reprinted in 4to. Lond. 1720.

In his maps, for the first time, are inserted the roads, the hundreds, and lines, apparently two miles apart, which divide the county, so as to save the trouble of mensuration, and to facilitate reference from the alphabetical index. His map of *Surrey* (1605) was much larger and more exact than any of the others; the survey was sold to a learned Hollander at the Restoration, according to AUBREY, who also mentions his *Kent*, which was in all likelihood undertaken with Kip. WEEVER, (p. 655), mentions the *Essex Survey* (1584), a thin folio MS. in Sir John Turner's library; and one of *Sussex* is also attributed to him.

There exist, a *Description of the honor of Windsor*, dated 1607, in the Harleian MS. 3749; and a *Survey of the manor of Blewberrie, county Berks, being parcel of the domains of the Prince of Wales*, dated 1617, taken by the subject of this notice and his son of the same name, deputed by Sir James Fullerton surveyor-general to the Prince; this belonged to Bishop More's library now at Cambridge. Bishop NICOLSON also mentions a *Survey of Skipton manor, county Berks.* He must have survived the year 1624, as he lived to finish, with his son, the *Survey of Sheriff Hutton manor, county York*, and he also wrote an *Account of the customs of the duchy of Cornwall*, formerly in the registers of the office. Another work was entitled, *A brief declaration of the titles, inhabitants, divisions, and situations of England or Britannia*, 4to. 1593.

He has also the credit of drawing, on eight sheets of paper, a *View of London*, with, at bottom, the Lord Mayor's show all on horseback, the aldermen in round caps. BAGFORD (p. 82) says, "This view is singular, and was

taken from the pitch of the hill toward Dulwich College, going from Camberwell to London, about 1604 or 1606," and that he had not met with any other of the kind. He adds, that "he saw it on the staircase at Dulwich College, and that Secretary Pepys went afterwards to see it and would have purchased it; but that since it is quite decayed and destroyed by the damp of the wall. It was given to the College with the library by Wil. Cartwright, an eminent comedian and bookseller."

Granger states, that "it does not appear that he received more reward than the employment in the survey of royal domains, for which he received a stipend of £50 per annum; that his topographical pamphlets, before they were reprinted, frequently sold for forty shillings each, and that his *Surveyor's Dialogue*, a work of merit, is very uncommon. This book has been through four editions in London, namely, 4to., 1607; 1610; 1618; and 8vo. 1738. The latter contained only the first three books, and has been used on the present occasion; the sixth is reprinted from the third edition, of which the title-page appears subjoined. With the omission of the fourth and fifth books, whose contents are stated in the index, it appears a work peculiarly fitted to the temper of the present times, when the Architect, far more frequently than any other professional authority, is called upon to give that advice, as to the best disposition of landed property, which he is as often entrusted to carry into effect. The work requires no other praise than a recommendation for perusal.

John W. Papworth.

THE

SURVEYOR'S
DIALOGUE,

Very profitable for all men to peruse, but *especially for Gentlemen, Farmers, and Husbandmen*, that shall either have occasion, or be willing to buy, hire, or sell Lands: As in the ready and perfect Surveying of them, with the manner and method of keeping a Court of Survey, with many necessary rules and familiar tables to that purpose.

As also,
The use of the Manuring of some Grounds, fit as well for Lords as for Tenants.

NOW THE THIRD TIME IMPRINTED.

And by the same author enlarged, and a Sixth Book newly added, of a familiar conference, between a Purchaser and a Surveyor of Lands; of the true use of both, being very needful for all such as are to purchase Lands, whether it be in Fee-simple or by Lease.
Divided into Six Books, by I. N.

Prov. xvii, 2:
"A discreet servant shall have rule over an unthrifty son, and he shall divide the heritage among the brethren."
Voluntas pro facultate.

A.D. 1618.

THE CONTENTS.

The First Book.—Containeth a communication between a Farmer and a Surveyor of Land; wherein is proved, that Surveyors of manors and lands are necessary both for the lord and tenant, and in what manner tenants ought to behave themselves towards their lords, in respect of their tenures.

The Second Book.—Is entreated between the Lord of a Manor and a Surveyor, concerning the estate of a manor, of the parts and profits thereunto belonging, and how the lord of a manor ought to deal with his tenants.

The Third Book.—Containeth the manner and method of keeping a court of survey, and the articles to be inquired of, and the charge; how to enter and enrol copies, leases, and deeds, and how to take the plot of a manor.

The Fourth Book.—Shewing the manner of casting up of the quantities of acres of all sorts of grounds by the scale and compasses, with tables of computation, for ease in accompting.

The Fifth Book.—Sheweth the different natures of grounds, and whereunto they may be best employed, how they may be bettered, reformed, and amended, fit for all farmers and husbandmen.

The Sixth Book.—Containeth a brief conference between a Purchaser of Land, and a Surveyor; wherein are some points necessary to be considered of such as are able and willing to purchase land in fee-simple, or by lease.

THE FIRST BOOK.

THE DIALOGUE BETWEEN A FARMER AND A SURVEYOR.

Farmer.

SIR, I am glad I have so happily met with you, for, if I be not mistaken, you are a Surveyor of land.

Surv. Admit it so, sir, what then?

Farm. I have heard much evil of the profession, and to tell you my conceit plainly, I think the same both evil and unprofitable.

Surv. You seem to be but a young man in years, and are you so deeply seen in the abuse of this faculty, that you can so peremptorily condemn it?

Farm. Call you it a faculty? What mean you by that word?

Surv. Ability to perform a thing undertaken.

Farm. Then this faculty of yours, I say, is a vain faculty, and a needless work undertaken.

Surv. Speak you this by conjecture, by report of others, or by due experience of your own?

Farm. I speak, indeed, as induced to the opinion I hold, by all the three reasons.

Surv. Then needs must you be either partial or malicious in the first two, and deceived in the third: for he that speaketh by conjecture hath not experience; and he that speaketh by report is as a trunk to convey an uncertain sound coming from one, to the ears of others; and if you speak by experience, then have you a pretence to have skill in the art; and by your own experience it seemeth, you condemn yourself to have abused the same, and so condemn a general necessary profession, in respect of your own particular error in the same.

Farm. No, sir, I am willingly unskilful in that contemptible vanity. But my experience groweth, by tasting of the evil that hath followed the execution of the thing, by some like unto yourself.

Surv. This is a general condemnation, rashly pronounced against all, for the abuse of some; and they only spew out greatest scandals, that are by examination in this business found most deceitful against their lords; and therefore no marvel, though the profession be contemned and condemned, of such as are to be condemned, for the offender cannot speak well of the apprehender, nor scarcely of the most just judge.

Farm. You speak as if you knew some abuse in me: I tell you, you do me wrong to attach me so.

Surv. Belike you think it free for you to censure other men at your pleasure, and to judge them after your own vain conceit, and yet no reply must take hold of your vain quarrel, that riseth of mere malice against the innocent.

Farm. Innocent? How can that be, when you pry into men's titles and estates, under the name (forsooth) of surveyors, whereby you bring men and matter in question oftentimes, that would (as long time they have) lie without any question. And oftentimes you are the cause that men lose their land; and sometimes they are abridged of such liberties as they have long used in manors; and customs are altered, broken, and sometimes perverted or taken away by your means; and, above all, you look into the values of men's lands, whereby the lords of manors do rack their tenants to a higher rent and rate than ever before; and therefore not only I, but many poor tenants else, have good cause to speak against the profession.

Surv. Be you not offended at the comparison which I will make to your allegations. Why should not such persons as are inhibited by the laws of the realm, to commit certain acts within the commonwealth, cry out against them, that by the same laws are appointed magistrates and officers to see these laws executed upon them, as rogues, beggars, and other like vagabonds? For if such officers and overseers were not, these offensive persons might have their wills: so should it follow, that men of peace, and good members of the commonwealth, should be endangered to be sacked of that they have, by such lewd persons. Necessary therefore is it, that there should be such as should see unto, inform, punish, and reform these. And by your assertions you may as well intend, under like reason, against keeping of courts in a manor, wherein many abuses are found out, reformed, and punished, which without such courts, would lie smothered, festering so long, that there would be few sound members left within the same.

Farm. It seems, you compare tenants of manors that are (many of them) honest, civil, and substantial men, to rogues, and vagabonds. You forget yourself.

Surv. My plain words are, that as well these evil members of the commonwealth, may speak against the Surveyors of the commonwealth, which (to speak only of the under officers) are the justices of the peace, constables, and such like, as may tenants of a manor speak against the surveying of their lands within the same.

Farm. That were strange: for by the one, the whole state of the kingdom is kept in peace, and by the other, many millions disquieted, that might live quietly in their farms, tenements, houses and lands, that are now daily troubled with your so narrow looking thereinto, measuring the quantity, observing the quality, recounting the value, and acquainting the lords with the estates of all men's livings, whose ancestors did live better with little, than we can do now with much more, because by your means rents are raised, and lands known to the uttermost acre, fines enhanced far higher than ever before measuring of land and surveying came in, and therefore I think you cannot but confess, that other men, as well as I, have good cause to speak of you and your profession, as I do.

Surv. I perceive that the force of your strongest argument is, as before I said, your fear and unwillingness that the lord of the manor, under whom, and in whose land you dwell, should know his own: and that you think it better for you, that he should continue still ignorant of what he hath, and that your estates should be always hidden, and what injury you do should be concealed, than than he should be acquainted with what you hold, and your abuses, encroachments usurpations, intentions, and wrongs discovered.

Farm. Sir, we acknowledge that the lord ought to have his rent, and that is all, and our services at his courts; but the land we have, is our own.

Surv. Howsoever you may account them yours, yet the lord hath such an interest and property in them, as he may also call them his; nay, I may say, you are not in such sort your own, but, next under the King, you may be said to be the lord's.

Farm. Fie upon you, will you bring us to be slaves: neither law, nor reason, least of all religion, can allow what you affirm, and therefore, as I before conceived, so I may now protest, that you, and such as you are, are even the cords whereby poor men are drawn into a servitude and slavery, and therefore I say again, it is pity any of you have any employment in the commonwealth.

Surv. What, sir, because I say you are in some sort the lord's? I tell you, that I mistake it nothing at all; for as the King is supreme head and prince, and defender of all his subjects, so under the King is every lord of a manor chief and head over his tenants, namely, over such as hold of him: and he hath a kind of command and superior power over them, as they are his tenants, and for that cause he is called, and they do acknowledge him to be their lord. And what doth the word lord import, but a ruler or governor? If he be your lord, then are you his, to be governed in causes determinable within the manor, and if they refuse the service due to the lord, the lord may distrain for it, or may enter upon their lands, and resume it as his own in some case; so that I may well say, that in a sort, even your lands and

yourselves are the lord's. The use and occupation is yours, but if the land were so yours as were none above you, you might then call it yours; but so is none but the kingdom, which the King holdeth of none but God. And no man is so absolute within the kingdom, but he holdeth his land of some manor, or person, or of the King. And of whom such land is holden, the same is called the lord of that land after a sort, because it is held of him by some kind of rent or service, and by possibility this land may come unto, and by law be cast upon the lord of whom it is holden, as, if you be so willing as you seem, to talk of these mysteries, you shall anon perceive. And therefore you cannot but say, that the land and yourselves are in some sort the lord's. And therefore is it lawful for the lord of the manor, to inquire and examine of the things in those kinds belonging unto him? And if there be clean and plain dealing among tenants, they need not fear who look into their lands and estates. But if there be deceits and wrongs against the lord, policy willeth you to banish any man, and to bar all the means that may discover them, though equity and honesty be contented to discover all things, to the manifestation of truth. Are not these the matters of chief importance that disquiet you? The measuring of your lands, the observation of the quality, and estimating the value of your lands.

Farm. It is true: for these are the causes our rents are increased, and our fines raised, and this would the lord never do, if such as you did not enkindle the lord's desire, by your too severe scrutations, examinations, impositions, and imputations: for were the lords of manors ignorant of these things, as in former times, poor tenants might have things at the rate they had in former times.

Surv. My friend, if I compare you to a dead image, be not offended, for I perceive you have eyes to see, and yet you see not, you have a heart to understand, and yet your understanding is amiss.

Farm. I am beholden to you, sir, to make me worse than a beast, for a beast hath the things you say I want: how prove you what you have said?

Surv. Because you impute your great impositions unto the act of an honest Surveyor, when I will assure you, and prove, that the cause is in and of yourselves.

Farm. Then indeed you might account us brutish, if we would work our own woe.

Surv. I perceive, though you may be a good worldly farmer, you are but a mean observer of the course and carriage of things passing daily under your nose. He that hath seeing eyes, and an understanding mind, may easily see and perceive, that there is no manor, nay, no farm, be it great, or little, far off, or near hand, but hath been and daily is discovered, by private intelligencers, lurking in or near the same, prying into estates, aiming at the quantity, wide, short, or over, seldom hitting right, observing also the quality, and glancing at the value of every man's land, and thereof secretly and underhand do inform the lords of the farm, and they being credulous overmuch, and not a little covetous, build their demands both of rents and fines, upon these most deceivable informations, whereby the lord is abused, and the tenant wronged: whereas, were the things seen, viewed, and surveyed by a judicious and faithful Surveyor, who upon due consideration, and discreet observation of all particulars, gives in a true and indifferent certificate unto the lord, using rather his uttermost endeavour to moderate and mitigate the lord's excessive demands than aggravating the validity beyond reason or a good conscience, you would be of another mind; and I protest, I hold that Surveyor a very bad man, that will, either for affection or bribe, carry a partial hand between the lord and his tenants; yet sith he holdeth as it were the beam of the balance, he should rather give the better weight to the weakest, respecting nothing but a charitable course to be held by the lord, for whom he travaileth with the tenant, against whom if he speak not, he shall be often suspected of the lord to be partial. But if there be equal consideration on all sides, the lord will believe the Surveyor deals justly, and the tenant rest satisfied, willing to leave, or readily to accept, as his own judgment agreeth or disagreeth with the things propounded. For this have I observed, that oftentimes tenants consider not when they are kindly used, neither see they at all times when they are abused.

Farm. Truly, I believe you in part: for, indeed, there are, even amongst us, in the manor wherein I dwell, officious fellows, that, to procure the lord's good opinion, will pry into men's estates, and, indeed, as you say, into the quantity, quality, and value of men's lands, and give false information oftentimes; and I know it is a foul abuse, and, of the two, I rather allow a true survey than a false report: for such fond fellows as are thus busy in other men's causes, are of all men least to be believed; for they speak always for affection or gain; for they will extenuate the value of them they love or have gain by, and aggravate the same, as their hope is of the lord's reward:—all this I know without your report. But what is that to the thing you charge poor tenants withal, that they are the cause of their own hard measure? Clear yourself of this slander.

Surv. That can I easily do by experience, and I think I shall have the whole world to witness it for your further satisfaction, who cannot yourself be ignorant of the same thing; for you have in part confessed it: for the former informers, of whom you last spake, are even tenants themselves; yet I accuse them not all, nay, I excuse none in particular: for I have seen and observed among them a kind of madness, as I may call it, but in the best sense it is a kind of ambitious, or rather avaricious emulation, wherein they strive one to outstrip another in giving most: as where myself have had business of this nature: namely, of letting, setting, or selling of land for years or lives, being, or near being determined, in farms or other like, whereby the lord hath been at liberty to dispose thereof at his will, for best advantage, by choice of a new tenant, proclamation to that effect hath been made in open court, where I have seen, and it is daily in use, that one will outbid another, insomuch as I have wondered at their emulation, and could not have asked what they have raised it unto themselves. And should any that is in authority in this case (who in duty is not to hinder the lord) or the lord himself, inhibit such hot spirits to climb as high for the lord's advantage, as the ladder of their own will, and supposed ability will willingly carry them? This is not as one swallow in a summer, but they are many, and everywhere winter and summer, and yet are other men accused and condemned for them and their faults, if their will (though wilful) be a fault: but I should think it greater madness for a lord, wilfully to refuse what is so voluntarily offered, and so willingly given. Now, who is the cause of raising rents and fines?

Farm. I know, such rash and over-forward men there are in the world not a few, almost in every manor, who are especially pricked forward to this emulation through envy and avarice, having means to achieve their desires. But this bidding and outbidding is in things, wherein the lord is at his liberty to take as tenant whom he list. But in customary tenements of inheritance the case is otherwise, where the rent is and the fine (for the most part) certain, what needs the lord have this surveyed, or any freehold lands?

Surv. It is fit the lord should know what his tenant holdeth, be it free or customary, though at this day there be a needless niceness in some freeholders of manors, who seem to conceal their estates, and to kick against the view of their lands: but if they knew what they did, they would reform that error.

Farm. Call it you an error, for a freeholder to refuse to shew his estate to the lord, or not to suffer his land to be surveyed?

Surv. I may well so call it; nay, I may call it a great fault, or an injury done against the lord, and hurtful to himself. There is none (it may be you know it) that holdeth land of a lord, but he holdeth the same by some kind of rent or service, and when he comes to take up his land after the death of his ancestor, or upon purchase, but he doth or ought to do fealty,

unto the lord of whom he holds it: the doing whereof, how ceremonious it is, if you be a tenant to any such land, you know, and wherein he maketh a solemn vow and oath, to be true tenant unto the lord for the land he holdeth. And sometimes the tenant of such a tenure, is forced to be aided by his lord for the same land, if he be impleaded for it: now, if such a tenant refuse to shew his estate, or to permit his land to be seen, how performeth he his oath, to be true tenant, and to do such services as are due unto the lord? Among which, this, of permitting the lord to know his own, is not the least, nay, he ought by his oath of fidelity, to further it by all means, both by his proper knowledge and evidence, not only his own, but other men's lands, and thereby he shall not only not prejudice himself, but he shall fortify his title so much the more, by having his evidence enrolled, and his land recorded in the lord's book of survey, that when his heirs shall take up the land, or he alien the same, it appeareth that he is true tenant unto such lands, for such rent, and for such services: but there be so many scruples thrust into men's heads by such as have a pretended skill in matters of policy in this kind, and lords of manors have been so remiss in taking knowledge of the things in this manner appertaining unto them, that questions of titles and tenures are daily had and moved, to the great trouble oftentimes both of lord and tenant, as is seen by experience daily, as well of land holden of the King, as of inferior lords, which may be reconciled, if tenants were not too curious, and lords too negligent. Besides this, there are other reasons to move the lord to know what land is holden of him, and by what title, rent, and service: for freeholders may forfeit their land, and their land may escheat unto the lord: if then he should be ignorant what land it is, where it lies, and how much it is, he may be easily abused for want of records: and so are many lords of manors, who for want of due knowledge of their tenants, and of their land and tenures, other men are intituled to their right.

Farm. You have said more than I heard or dreamed of, and it holdeth in some sort by reason; how it is by law I cannot dispute; but in all that you have said, you have not satisfied me in the thing before I spake, touching the fines of customary tenants of inheritance, which (as I said before) have been of late raised far higher than in former times, by your Surveyors.

Surv. You strike always one string, and I find the sound of your meaning: you would always be as easily charged in your fines as might be; and in that I blame you not, it is every man's case to bear as light a burden as he can. But if you remember what I spake before, touching the cause of this raising of fines, where I proved it came most by your own means, you may be the sooner satisfied in this, for it is in nature like the former. Although this kind of tenant hath seldom any competitor, to emulate his offer, because the tenant leaveth commonly one either in right of inheritance, or by surrender to succeed him, and he by custom of the manor is to be accepted tenant, always provided, he must agree with the lord, if the custom of the manor hold not the fine certain, as in few it doth: now this composition is commonly made by demand of the lord, and offer of the tenant. The lord asketh according to his conceit of the value of the thing, and either his knowledge must arise by his own experience, or by information: the information is either by secret intelligence of some officious neighbour, or by due judgment of an indifferent Surveyor, namely, such a one as carrieth equal respect to lord and tenant. And although, as you allege, former times did afford tenants more favour in rating and arbitrating fines, as you suppose, if you consider it well it is now as then it was.

Farm. You much mistake it: for I will shew by ancient court rolls, that the fine of that which is now twenty pound, was then but thirteen shillings and fourpence, and yet will you say they are now as they were then?

Surv. Yea, and I think I err little in it. For if you consider the state of things then and now, you shall find the proportion little differing: for so much are the prices of things vendable by farmers now increased, as may well be said to exceed the prices then, as much as twenty pound exceedeth thirteen shillings and fourpence.

Farm. You speak far from truth, and I marvel you will err so much, pretending to be a man of that reach, that men employ you to overreach others.

Surv. To shew you then an instance, look into the chronicle in the time of Henry the Sixth, and you shall find, that a quarter of wheat was sold at Royston in Hertfordshire for twelve pence: and I trust, if you be a farmer, you are a corn-seller, and I think, if a man offer you thirty times as much for a quarter, you will say it is better worth.

Farm. Was it possible that corn was then and there so cheap, and to rise since to this rate? It is very strange.

Surv. Not at all: for since there grew such an emulation among farmers, that one would outbid another, (which in the beginning was little seen) it grew at length that he that bought dear, must sell dear, and so grew the prices of things by degrees to this rate as now they be; and a farmer gets as much by his farm now, as then he did.

Farm. You err therein, I assure you: for else could farmers keep as good houses and hospitality now, as they did then, and alas, you see how unable they be.

Surv. It is true, and the reason is manifest; for where in those days farmers and their wives were content with mean diet and base attire, and held their children to some austere government, without pride, haunting alehouses, taverns, dice, cards, and vain delights of charge, the case is altered; the husbandman will be equal to the yeoman, the yeoman to the gentleman, the gentleman to the squire, the squire to his superior, and so the rest, every one so far exceeding the course held in former times, that I will speak without reprehension, there is at this day thirty times as much vainly spent in a family of like multitude and quality, as was in former ages; whereof I speak. And therefore impute not the rate of grounds to a wrong cause, for to tell you truly, both lord and tenant are guilty in it; and yet they may be both content, for they are as the sea and the brooks; for as the rivers come from the sea, so they run into the sea again.

Farm. To tell you truly, you have said more than I have heard, and indeed it stands with some reason; and you have in part satisfied me, that the cause of our complaint is not so grievous as I and infinite others have supposed it. Yet to tell you, as I and others have found, there be some of your profession have either none at all, or little, or very hard consciences, and, for the most part, such as have least skill, and such, indeed, I think unnecessary for lord or tenant; for they cannot but abuse the one or other by their reports; and the records which they make may breed quarrels many years after. And, therefore, as the Surveyor is a member (as you hold) not only tolerable, but necessary, I wish there were fewer, and they honest, just, and skilful; for, to tell you truly, we have thought among us countrymen, that there are more than can be employed, as it seemeth by their public declarations of their want of work; for as I have passed through London, I have seen many of their bills fixed upon posts in the streets, to solicit men to afford them some service; which argueth, that either the trade decayeth, or they are not skilful, that beg employment so publicly; for a good workman needs not stand in the streets or market-place.

Surv. I confess, in this you have said truly: for none that is indeed fit for employment, will, or needs to crave it, in such manner, for they will be sought unto and solicited. But every one that hath but a part of the art, nay, if he can perform some one, two or three parts, is not thereby to be accounted a Surveyor, as some mechanical men and country fellows, that can measure a piece of land, and though illiterate, can account the quantity by the parts of money, as a penny to a perch, a groat to a day's work, ten groats to a rood, and consequently, a mark to an acre, which manner of casting sufficeth, and satisfieth them in their small accounts, but the manner of their measuring is

often erroneous, as I will shew you hereafter, if leisure serve. Some have the skill of plotting out of ground, and can neatly delineate the same, and by arithmetic can cast up the contents, which is a necessary point of a Surveyor's office, but not all.

Farm. Saving your tale, sir, we poor countrymen do not think it good to have our lands plotted out, and methinks indeed it is to very small purpose: for is not the field itself a goodly map for the lord to look upon, better than a painted paper? And what is he the better to see it laid out in colours? He can add nothing to his land, nor diminish ours; and therefore that labour above all may be saved, in mine opinion.

Surv. They that speak at any time against anything done, or propounded to be done, do either shew their reasons against it, or else they conceal their conceits, and without any good argument, inveigh only against the thing; and I know your meaning in misliking plotting of your land, and yet you utter not what you think; for a plot rightly drawn by true information, describeth so the lively image of a manor, and every branch and member of the same, as the lord sitting in his chair, may see what he hath, where, and how it lieth, and in whose use and occupation every particular is, upon the sudden view; which tenants mislike, not that the thing itself offendeth them, but that by it they are often prevented or discovered of deceitful purposes: for a tenant that is both a freeholder and a copyholder for life, or by indenture for life or years, holding these lands intermixed, may easily (unless the land for life or years, be very especially butted and bounded in their copies or leases, as seldom they are, through the sloth of some stewards, or for default of a true survey to guide them) appropriate unto himself copy or leased land for free, and especially having time enough to alter names and properties, to remove meers, and to cast down ditches, to stock up hedges, and to smother up truth and falsehood under such a cloak of conveniency, as before it be suspected or found out by view, it will be clean forgotten, and none shall be able to say, this is the land; whereas if it be plotted out, and every parcel of free copy leased, and the rest be truly distinguished, no such treachery can be done against the lord, but it shall be most readily reconciled. And I dare presume to say, that the want of due plots and descriptions of land in this form, hath been the occasion of infinite concealments, and losses of many men's land, and many intrusions and encroachments have been made, and so long continued, that now neither memory nor record can reform them; besides infinite other abuses, which are daily done, to the prejudice of lords, for want of such a monument to be always at hand for their instruction.

Farm. You aim, unhappily, I think, to some men's purposes; but for my part, I promise you I had no such thought in me, and yet what you say, may indeed be easily wrought in most manors, if they be as the manor is wherein I am a tenant: for I am persuaded, there hath not been any view taken of it, or perambulation made, or survey had, within the memory of any man alive. And to tell you truly, I think the lord hath much wrong both by his own tenants, and by confining lords; for so the lord have his rent, and his other duties of us, he is contented; but I may tell you, if he did better look into it, it would be better for himself and his hereafter, yet we wish he would let it rest as it doth, for we may do in manner what we list, and if a Surveyor come, we shall not do as we have done, nor hold that that some have held long without any trouble; but that I leave. Then you say, that plotting is the chief part of a Surveyor's skill.

Surv. I say not so, but I say it is necessary for him that is a Surveyor, to be able to do it, and that he be painful and industrious, and having this quality with the rest more necessary, he may be then called a Surveyor.

Farm. What are they, I pray you?

Surv. To little purpose I think I shall tell you; yet because you may know that every one that hath the name, is not indeed a Surveyor; for besides the former faculty of measuring and plotting, he must have the understanding of the Latin tongue, and have some sight in common laws, especially of tenures and customs, and must be able to read and understand any ancient deeds or records, French and Latin, and to judge of the values of land, and many other things, which if time will permit, I will hereafter declare more at large unto you.

Farm. Why is there such a precise knowledge required in a Surveyor?

Surv. Because they are employed in such businesses as concern greatest persons in their estates; for although men be endowed by the providence of God, and of his bounty, with honours, manors, castles, houses, lands, tenements, woods, and other like revenues, which indeed are the sinews and ligaments which conjoin and tie honour and ability together, yet if these be not managed, guided, and carefully continued and increased by a discreet and honest Surveyor, for, and in the name and behalf of his lord, and the lord again proportion his expense and charge according unto or within the compass of his known incomes, the lord may be disabled to maintain that which he hath gotten, the title of honour; and where honour is without means, it wanteth the substance, and hath only the shadow of itself to delight in.

Farm. It behoves not only men of nobility, but inferior men also, to look unto themselves, for the preservation of their estates, but they indeed that have but little may quickly view it: *sufficit exiguo strigilatio curta caballo.* But he that hath many honours, manors, lordships, tenements and farms, cannot himself take view of them all with ease; for indeed they lie for the most part dispersed in many parts, and they must be aided by the skilful and industrious travail of some judicious Surveyor, who finding by his view and examination, the true values and yearly possibilities of his lord's lands, may be a good mean to retain his lord within compass of his revenues, and to work him to be good to his tenants, and by that means the Surveyor shall deserve praise, and his lord win more honour. But I marvel how such great persons did before surveying came up, for this is an upstart art, found out of late, both measuring and plotting.

Surv. You speak, I think, according to your conceit, but I will prove it far otherwise, that measuring, plotting, and surveying, hath been used in all ages of old. As for description, it was used in Egypt by Ptolemy the King, who described the whole world. And where the river Nilus in Egypt overflowed the banks (as at this day it doth about harvest) the violence of the inundations was such, as they confounded the marks and bounds of all the grounds that were surrounded, in such sort as none knew his own land; whereupon they devised to measure every man's land, and to plot it; so that afterward always at the water's recess, every man could find out his own land by the plot.

Farm. Truly that was a most excellent invention, and I think it indeed a most necessary course to be held in some grounds that I know in England, which are subject to like confusion: many marsh lands near the sea coast in Kent, Sussex, Essex, Suffolk, Lincolnshire, Cambridgeshire, and other shires confining the sea, are subject to great waters, and if they were thus plotted out as you say, I must needs confess it were a good work, howsoever these kinds of grounds should be hereafter surrounded, increased, or diminished, by the force of the sea's continual rage, whereunto they are daily subject, for by that means, if the ditches, which are the ordinary meers, metes, and bounds, between several men's lands, be confounded, this device might, after the winning of these surrounded grounds again, truly reconcile them, and allot every man his own, which otherwise will be impossible to bring to true appropriations. And this, in my conceit, is not the least part of your profession, to lay out grounds in their true forms, that every several parcel may be distinguished from other; for I know where great strife hath risen by confounding one manor with another, where the sea hath won and lost ground, and devoured the true bounds, of which I am not alone witness; and it is daily seen, that questions do arise by like casualties, where towns, houses, fields, woods, and much land, hath been and are daily devoured, and in some places augmented; rivers by force turned out of their

right courses upon other confining lands; whereof time hath taken such hold, as the truth is now brought in question, to the stirring up of quarrels between parties, which, if these places had been formerly laid out in plot, the doubt would be easily answered. In these things I cannot but agree with you, that your profession may stead men that have use of your travail in this kind, although no such art hath been used, nor is it reported to have had any use in the Word of God.

Surv. Is there a necessity to produce the use of this, from examples out of the Word of God, when these indifferent things are left to the discretion of man, for matters of politic and civil society? If every profession should be driven to fetch authority from the use in sacred things, many things plentiful amongst us that live in a commonwealth would be found profane; but because you seem to urge it, I will not stick to let you know, that it is not without example in the Old Testament. If, first, you will have the proof of measuring, look into the second Chapter of Zacharias, and there shall you find, that the prophet reporteth, that "he saw a man with a measuring line in his hand, and he asked him whither he went? and he said unto him, To measure Jerusalem, that I may see what is the breadth thereof, and what is the length thereof."

Farm. I do remember now that I have read such a thing indeed, but, as I take it, this measurer was an angel of God.

Surv. Then is the warrant of measuring so much the more strongly confirmed unto men. But you may perceive, that measuring was then in use in other things; for had not there been the use of the measuring-line before, how could the prophet have known it to be for that purpose?

Farm. Yes, being a prophet.

Surv. He could not have called a thing by its proper phrase (to the understanding of other) that had not been in use before, neither could his relation thereof have been understood of them to whom he declared it, unless they also had before known the like.

Farm. Can you prove the like of surveying?

Surv. Joshua commanded the children of Israel, that every tribe should chose out three men, that he might send them through the land of Canaan, to view, survey, and to describe it; for so is the word, "Ye shall describe the land into seven parts, and bring them hither to me." And what description could they make, without viewing and surveying the places?

Farm. It is true that you say, such a view was taken at that time, that every tribe might have his portion of inheritance. And surely in these Surveyors was much trust reposed by Joshua, the chief head of the children of Israel; for, according to their report, did Joshua divide to every tribe his portion. This, surely, was a work of great discretion and judgment in the Surveyors, and great providence in Joshua; for, indeed, he could not travail in all those parts himself, and, therefore, he did wisely to appoint such as were fit to perform the service; and it makes me remember your former defence of the profession, in travailing for great persons, who cannot afford time nor pains to view their own lands themselves. And it is not every man's gift to be able to divide lands into equal, or certain unequal parts, that men that are parties therein, may hold them equally dealt withal, unless it be such an one as hath skill in dividing and apportionating, which thing comes often in use among men in this commonwealth. And further authorities, or better warrant than these you have produced, for my part I will require none, unless you can and will voluntarily shew some later examples within our own kingdom, done in our forefathers' times, for I like not novations and new devices that our forefathers have not seen or done.

Surv. If you had time and experience to look into, and to understand what hath been done concerning this matter long ago, you should find in the records of the Tower, even before the Conquest, matter to satisfy you that this profession was then in use, and there shall you find the fruits. And since the Conquest, the book called *Domesday*, lying in the Exchequer, will confirm you, I think, sufficiently, that it is not, as you say, a new invention. Besides, the same art hath been, in sum and substance, established by Act of Parliament (3 *Edward* 1), and called *Extenda Manerii*; upon which statute, that learned judge, master Fitzherbert, hath written a little commodious and compendious treatise; so that if you stand upon any further authorities, I will leave you to the present general use thereof, which men of best discretion and greatest revenues do hold and continue, and none spurn against it but the malicious or ignorant.

Farm. I confess, I was lately ignorant of the things which now in part I know, but I was never malicious: as for the records and statute whereunto you refer me, I believe you without further search, and for my own part, I am sorry that ever I have so, with others, backbitten the profession, and slandered the honest professors thereof; for I now do well see, and plainly understand, that the same is lawful and expedient, and not any way hurtful unto the tenants, if the Surveyor be skilful and honest, and his information (given by skilful and willing assistants, which are the tenants themselves) be true, and his help of the lord's records ready; for these are the two pillars, upon which a Surveyor must of force build his work, information and record, as I take it, although record be always preferred before verbal intelligence; yet if records be never so authentic and true, of things unknown to him that hath the examination of them, what can be effected or done, but as by a blind man that knoweth his face is to his way, but how and where to step he is uncertain? and although he desire none to bear him, because his legs are sound, yet he will not refuse to be led by the hand the way he would go. So a Surveyor, in my poor opinion, that hath a bundle, nay, a whole trunk full, of records of several tenements and parcels of land, whose names he can read, whose buts and bounds he can relate, but yet he sees not the way of himself to go to them, or can say, without direction, "This is this or that piece of land," and therefore I know that tenants must give aid to a Surveyor, or else he will fail, though not in his art, yet in truth of his work.

Surv. You have said well, and it appeareth your apprehension is good in this business, and, indeed, the aid of the tenants is a good help in this case, especially when records are also present; for if record and their information concur, then is the Surveyor in the right way. But many times, if the Surveyor cannot help the tenants by his records when they are at fault, he shall hardly find which way his game goes; for a skilful Surveyor, carrying his record in his hand, in his perambulation of a manor, shall, after the first entry, be able to guide himself, and go from place to place, from field to field, even by his own evidence, if they be truly made, and the buts and bounds right, especially if the names continue unaltered, and that the tenants can avow it as he citeth it, and nothing then is to be altered, but the names of owners, who change often. And for this business, the fittest men to accompany the Surveyor abroad, are the most ancient, and longest inhabitants within the manor, for the Surveyor's instruction; and the youngest, to the end they may also learn to know the like, to give like aid by their experience to posterities.

Farm. Methinks it were a good course (if I be not too saucy), that a Surveyor should, after his perambulations made, and the particulars entered, publicly read the same before the tenants in open court, to the end that they may approve or reprove what is true or mistaken, for the best may err in setting down many things.

Surv. I like your advice well, and surely he that doth not so, and compare it also with former records, doth not as behoveth. But I know, and have found by trial, that tenants think it a hard imposition, once in their life-time, to attend such a business,—they had rather do any work than to do their lord service, and themselves this good; for many of them are so wise in their own conceits, as they think them fools that give any assistance unto this work; and some so wilful, that if they knew that they and theirs should be for ever benefited by it, they will stand

aloof, and any small occasion of their own will easily withdraw them from it; and some, again, are so worldly, that they think no day well spent, but that is spent upon their present profit; and, lastly, some are so given to their vain delights, as neither love of their lord, or fear of forfeiture of their tenements, or doing good to their neighbours, or securing their posterity, can get any duty in this behalf to be done by them.

Farm. As far as I conceive, the lord of a manor may force his tenants at such a time to give their attendance; else, you may well think, not a few would find excuses enough to absent themselves.

Surv. You say well, and therefore hath the law provided a punishment for those that will not do their duties in this, or in anything that the lord hath to do within his manor, for ordering of his tenants. And because tenants should not be forgetful of their duties, they were in former times, and may be still, summoned to the lord's court every three weeks at this day. And the lord's remissness in calling them, hath bred in many places a kind of contempt, whereby groweth their slackness in times of their lord's service. But the lord of a manor hath power to punish them, and they are remediless without submission, if the pain be within the compass that the court will bear, which is large enough to weary him that is most arrogant.

Farm. You have satisfied me in many things whereof I doubted, you have cleared the profession itself of many slanders, and for my part I will henceforth speak more sparingly, and advise such as I hear too forward to be better advised.

Surv. Every manor is a little commonwealth, whereof the tenants are the members, the land the body, and the lord the head; and doth it not follow that this head should have an overseer or Surveyor of the state and government of the whole body? And follows it of necessity, that the office is unlawful? An unjust officer maketh not the office unjust, no more than a crabbed face impaireth the fair glass wherein it looketh, or a dusky cloud corrupts fair water whereon it lowereth. In case of survey of land, against which you have so much inveighed, if you consider it in reason, and make it your own case, you will say, perchance, the case is altered. You have now peradventure a small farm, will you be careless and dissolute of the state thereof? Will you not weigh and consider with yourself what land is fit for pasture, what for arable, what for meadow, and the like? And will you not command your servant to view it daily, that no trespasses be done therein, and to see unto the hedges, ditches, fences, water-courses, gates, and such like? Will you not regard the estate of your cattle, their number, health, and safety? And have you not a continual watch over all your servants and children; and to the preservation of things within and without? If you do thus in one small farm, what would you do in many?—could you see unto them all yourself? If you had as many manors, would you lie at home and receive the rents and fines that your tenants would bring you, without consideration of the estates or values, quantities or qualities of the things for which you receive money? And why have you this care, or would you look into these things? Is it not, because it is your living and livelihood, by which you and yours are maintained? And how much the more it is neglected, so much the more it decayeth; and if it decay in quantity, you cannot continue equal in quality. And can you, therefore, think it a hard course in that lord (that having his lands, which are his livelihood, dispersed in divers parts of the realm, to which, through greater employments of importance, he cannot personally resort; if he could, it is neither for his experience, nor fit for his calling, to travail therein), to authorize and send such as may take view of his revenues, and of the estates of his tenants, who are, by custom and law, in many things bound unto him; and that by such, his substitute, he may be truly advertised of what he hath, and how his means do arise, that he may proportion his charge and expenses accordingly? and whether he be abused by his tenants, or his tenants by his officers, or one tenant by another, or the lord wronged by confining lords, by intruding too far into his lands, how rents be answered, and customs continued, how freeholders do perform their suits unto his courts, how his tenements are maintained and repaired, how his woods are preserved, his fishings, fowling, and prerogatives, maintained?—all which, by how much the more they are neglected and let run without view or survey, so much the more doth the lord weaken his estate, and prejudice his heir; wherein, it cannot be denied, he offendeth God, deceiveth the King, and defraudeth the commonwealth. God, in that he is careless of his blessings bestowed upon him; the King, in that he wilfully disableth himself to do him the service he oweth him in body and goods; and the commonwealth, in that he disableth himself to give it that assistance that his quality and place ought to afford; and, consequently, sheweth himself unworthy to oversee matters of state and commonwealth, that is careless to see unto his own. Furthermore, where a due and true survey is made and continued, there is peace maintained between the lord and his tenants; where, if all things rest between them confused, questions and quarrels arise, to the disturbance of both. In private families, if there be none to oversee and to manage things domestically, what disorders, what outrage, what uncivil and ungodly courses, and what spoil and ruin of all things do follow? The like, of necessity, where tenants are left unto their own wills; and yet, as the unruly company in a family could be contented to be masters of themselves, and to have no controulment; so tenants can well brook their lord's absence, and that they might be their own carvers, and that the lord should have what they would yield of their own accord. I speak not of the honestly minded; but where a multitude is without a guide or governor, there is disorder; and disorder breedeth complaints; and complaints are unsavory to a kind landlord, who must be forced for redress to punish the offenders; and the most offensive will speak most of their wrong, and will soonest exclaim against any course that may keep order. So that, to conclude, I affirm, that it is most requisite and expedient, for due order's sake, that every lord of a manor should cause his lands to be duly seen, and truly surveyed and certified, and once in seven or ten years to have it reviewed; for the inconveniences that grow by the neglect thereof, are of so many kinds, and they so dangerous (like the most perilous disease long concealed), that they work contempt in the tenants, and loss to the lord. Now, to keep this upright between the lord and his tenants, I think you cannot deny, but a true and honest survey is necessary and lawful, and may be performed with a good and safe conscience, and in the fear of God, if (as I have said) the conscience be not before stained with the corrupt desire of unlawful gain; and (as I said before) I think few or none will mislike the course, but such as are far gone in some disease of deceiving their lord, which cannot endure to have this kind of salve to come near their sore.

Farm. Truly, sir, I know not how to answer you, but do consent to that you affirm; for, for mine own part, I cannot but confess, I can find nothing in mine experience to contradict your speech. But pity it is that Surveyors should be ignorant or unhonest; for the one especially abuseth the lord, and the other wrongeth both lord and tenants.

Surv. But whether is there cause in your conceit, to approve or reprove the profession, as it is simple in itself? Deliver your mind plainly, leave not a scruple in the minds of your neighbours, that have exclaimed with you against them that never offended them, reproving, as much as they durst, lords, for looking into their own lands; and, unless lords were dead images or pictures of men, having only the name of lords, and could not at all command their tenants, that could neither hear, see, nor consider, what were fit to be done with their own proper revenues, I cannot but wonder that any should spurn against them herein.

Farm. I think you speak something too forcibly against tenants in general; for, surely, all are not opposite to this course, though some be.

Surv. I condemn none; but I reprove some, that of mine own knowledge have given testimony of their inward dislike, by their outward murmurs; for, what is done with an evil will, cannot be said to be done at all. Such as come cheerfully to the service are dutiful, and I hold it impiety to abuse them; but the unwilling deserve little favour.

Farm. What should tenants principally do in such a business?

Surv. Nothing, but that law, custom, and duty requireth at their hands: to give their best aid to the Surveyor, to travel with him about the circuit, buts, bounds, and limits of the manor, to inform him of the same, and of every particular man's land and rent, to shew him their copies, leases, and deeds, to the end he may enter and enrol them all together in a fair book, for the lord's use, and for a perpetual record for themselves.

Farm. For information, and shewing the particular grounds and bounds of the manor, indeed is fit; but for their evidences, as their copies and leases, the lord hath the Court rolls of the one, and counterpaines [counterparts?] of the other; and for freeholders' deeds, their land is their own, and whether they may be compelled to shew them or not, I cannot tell.

Surv. These are frivolous doubts that some have formerly made, but they have been answered to their cost, for the law hath compelled them to shew their evidence. For, admit the lord of the manor have the rolls wherein the copies are recorded, may not copies be abused after their entries, or counterfeited in some things prejudicial to the lord, as may also the lease, as hath been found oftentimes,—names and lives of men, parcels of lands, dates of years, and such like, rased, inserted, or altered? And is it not fit, therefore, that they be seen and entered together, that without search of so many Court rolls the lord may be satisfied, and the tenants justified? And what prejudiceth it the tenant to have his evidences truly recorded, if he mean plainly,—be it copy, lease, or free deed? he may think it a confirmation of his estate, what casualty soever come to the same, he may be the better assured that such a record will witness with him; whereas, if none such appear, his interest will be the more suspicious; and, therefore, such as are wise and discreet, will not only consent to this good course, but be thankful unto the Surveyor as behoveth. If it be just and right that the lord should know his own, and who should manifest it but the tenant himself? and how should he do it but by his evidence? And most unjust it is, in that tenant, that, by any wilful or sinister means or covert practice, doth either detract his fellow-tenants from the service, or concealeth anything that may further the same.

Farm. This I cannot deny, although, indeed, some busy fellows will dissuade and breed a doubt herein; but I see it is to good purpose, and for our better security, to do all things requisite in this business, and that all the tenants within the manor should conjoin in one, and every one for himself, and all for one, and one for all, should seek, examine, and declare the uttermost truth of every thing towards the exact performance of his service, and that the Surveyor should know the quantities, qualities, and indifferent values of every man's tenements and lands, their rents, services, custom, works, and whatsoever the tenant is in law or conscience bound to yield or perform to his lord: and, indeed, thus much have I heard given in charge at a court of survey, with many other articles which are now out of my mind—all which may be done by tenants with a good conscience, both by relation in courts, and in the perambulation; but the concealing of these cannot stand with a honest mind in mine opinion; for these things, of themselves, cannot prejudice the tenants, but the misconceiving, misentering by the Surveyor may be erroneous, and the over-racking, urging, and over-burdening the tenants by the lord may be extortions. These things may fall out by means of an unjust and unskilful Surveyor, and a covetous landlord. And the fear of this maketh the tenants to extenuate the values, and to smother the truth of things, to their soul's danger; therefore, happy are those tenants that have a gracious lord and an honest Surveyor; for then there cannot be but an equal and upright course held between them; then cannot the tenants but be faithful and loving to their lords, and their lords favourable to them; so should the tenants be defended by their lords, and the lords fortified by their tenants, which were the two principal causes of the original foundation of manors, as I have heard.

Surv. You say rightly, and I am glad to hear you conceive so well of this apparent necessity; for, so may I say, that it is of necessity that the lord should know the full and absolute estate of his manor, and of every particular thereof: for, howsoever of late days tenants stand in higher conceits of their freedom than in former times, if they look a little back into antiquity they shall see that tenants (for the most part) of every manor in England, have been more servile unto their lords, and in greater bondage than now they are, whom the favourable hand of time hath much enfranchised, and it cannot be altogether everywhere forgotten, because they may see as in a glass, the picture of their servitude in many ancient custom rolls, and in the copies of their own ancestors, and many servile works have been due and done by them, and in many places yet are, though the most are now turned into money; but neither their enfranchisements, nor the conversion of works into rents, do so far free them, but that they still owe services unto their lords, in respect of their tenures, as well freeholders as customary tenants, as both in most of their copies and deeds is expressed in these words, *pro reditu et servitiis inde prius debit, et de jure consuet.* Which proveth their tenures in a sort to be conditional; which condition, if it be wilfully broken by the obstinate carriage of any such tenant, he endangereth his estate.

Farm. It were hard, if for not doing some small service unto his lord, a man should forfeit his living.

Surv. And it were very foolishness in a tenant, for wilful refusal thereof, to endanger the same; for if the lord be in law tied to maintain the right of his tenant, and to defend him against any other that shall pretend a false title unto his land, the tenant is again bound to perform all such services, and to pay all such duties as of right he ought unto his lord. And it is expedient that the lord should see these duties continued, and it hath been and is daily observed, that the neglect thereof extinguisheth the remembrance of them, and so the lord loseth his inheritance; for every service of the tenant is parcel of the same, and the remissness of looking into these tenures, hath brought it to pass, that infinite within this kingdom, that hold in fee, quillets of land, and some manors, know not how or of whom they hold; so that hereby lords of manors, of whom these quillets were heretofore known to hold, have lost their tenures and services, and such as hold the land by unknown tenures, are cast into the danger, to hold to them and their posterities further hurt.

Farm. If tenants will be wilfully obstinate, and refuse to do and continue their uttermost services unto their lords, as bound by their tenures, being (as you say) parcel of the lord's inheritance, they are worthy to be attached of disobedience, and to pay for their contempts; and if lords will be so negligent, as they will not look unto their own, they are worthy to lose their right; and therefore I hold it discretion in the one to do his duty, and providence in the other to continue what is due; and if by age or impotency the tenant be disabled in person to perform his service, to crave dispensation, or to do it by another; and if the lord be far off and cannot be present, to substitute one to receive it for him. But, sir, in all your discourse, I have observed, you have pleaded (as it were) for their lord, against the tenants, exacting sundry duties from them to their lords, but I have not heard you speak much against the lords, in favour of the tenants, and yet I know there is a kind of reciprocal bond of duty each to the other, and may be broken of either side.

Surv. It is very true; for as children are bound to their parents by the bond of obedience, so are the parents bound to their children by the bond of education; and as servants are

bound to their masters in the bond of true service, so are the masters bound to their servants in the bond of reward. In like manner, tenants being bound unto their lords in the bond of duty, so are the lords bound unto their tenants in the bond of love; and though I have said little at this time of the duty of lords to their tenants, the occasion hath not been offered at this time.

Farm. I trust you have said enough concerning the duty of tenants, for they can but pay rent, and do service, more cannot be exacted.

Surv. Yet rent and services are divers and diversely answered and done, which I could be content to shew you more at large, but that yonder comes a gentleman that will interrupt us; know you what he is?

Farm. I will tell you by and by as he comes near. Oh, sir, it is my landlord, a man of great possessions, lord of many manors, and owner of divers farms, who hath been inquisitive for a man of your profession, but to tell you truly, I altogether dissuaded him before this time; but now having heard your reasons, I will solicit him for your employment, and I would wish you might undertake first the manor wherein I dwell.

Surv. At his disposition and pleasure be it; and so for this time I leave you.

THE END OF THE FIRST BOOK.

THE SECOND BOOK.

THE DIALOGUE BETWEEN A LORD OF A MANOR AND A SURVEYOR.

Lord.

FRIEND, of late I met with a tenant of mine, who told me you are a Surveyor of land.

Surv. I have been, and am sometimes employed in that kind of service.

Lord. I have at this time some occasion to use the aid of one of your faculty; and I have heard by my tenant, that your skill and diligence may satisfy my desire therein.

Surv. I shall do mine endeavour wherein you please to command me.

Lord. There be many, I know, that bear the name of Surveyors, but when they are put to it, they come far short of some principal points required in the absolute performance of the work, and either leave it half done, or so shuffle it up, as the lord is abused, and the tenants wronged, by the blind and uncertain returns of the Surveyor's travails; for a lord of a manor knoweth not, but by such as he useth therein, the estate of things, and how the particulars stand between the lord and his tenants. If the lord of the manor have never so good a mind to deal well with his tenants, and the tenants be never so inclinable to do true duty to their lord, they may be both misled by an unskilful Surveyor, to the unjust condemnation or suspicion of both. And, therefore, I think it behoveth men of worth, that have use of such as you are, to be well assured of the skill and ability which you pretend to have in your profession; and, because I have no further experience of you than the bare report of my tenant, I must entreat you to discourse unto me a little of your knowledge, of such particulars as are to be considered in the absolute survey of a manor.

Surv. Sir, you seem to oppose me far, and the thing you demand will require a longer time and a larger discourse than either my leisure, or peradventure my present memory of every particular, will readily permit. And it may be, that you that pretend little knowledge in the art, may apprehend both the truth of the thing, and an error committed in the performance, as well as he that assumeth the title of a Surveyor, although neither your leisure nor your quality may in reason permit you the travail in it; for I know many gentlemen of good worth, that have the speculative parts of the whole, and the practice of the deepest, and yet they will not be seen to tread that path that a Surveyor is forced to do, in the whole business. You have the matter and subject whereon a Surveyor worketh, and without which a Surveyor loseth both art and name; and, therefore, you cannot be altogether ignorant of the things required in the business: as the master of a feast cannot dress the dainties, but the cook; yet can the master reprove the cook if he do not his duty therein.

Lord. Thou sayest true in thy comparison; but for my part, although indeed I have land, and I know how many manors I have, their names, and where they lie, and the most of my tenants, and their rents, (and if you should err in these, it may be I might be able to reprove you), yet for matters of further search, I assume not to be skilful, for then I needed not your service, as of quantities, qualities, values, validities of estates, tenures, customs, and other things incident to a manor, which are not in all manors alike, the true discovery whereof belongeth to the Surveyor's office, yet none but such as are truly skilful can sufficiently discharge the duty herein required; and therefore by your leave, you shall briefly (I will not be tedious) relate unto me what you can say of the definition of a manor, whereof it consisteth, how, when, and by whom it was erected, with other such things as shall be expedient for the lord of a manor to know, the particulars whereof I will leave to your relation, and first tell me what a manor is.

Surv. Sith you will needs dive into my poor skill, by your opposal, and sith indeed I do in some measure profess the art, wherein I think no man is or hath been so exquisite, but he might err in some point or part, much or little, as in other arts, yet to answer your demands, I will as briefly as I can satisfy your desire. And first, where you demand what a manor is: *a manor in substance is of lands, wood, meadows, pasture, and arable; it is compounded of demesnes and services of long continuance* (*Perk.* fo. 127). As touching the beginning of a manor, and the institution thereof, the beginning of manors was, when the King gave lands unto his followers, in such quantity, as did exceed the proportion of a man's manurance and occupation, as a thousand, two thousand acres, more or less; which quantity of land being at that time as it were in a lump or chaos, without any distinction of parts, or qualities of land, he to whom such land was given, to hold to him and his heirs for ever, enfeoffed some others in parts thereof, as one in ten, another in twenty, and some in more, some in less acres, and in consideration of such feoffments, every of these were to do the feoffer some kind of service, as he and they agreed upon, reserving such a part unto himself, as he might conveniently occupy in his own hands, and by this means the land thus given by the King, and thus proportioned out to others by the donee, became to be called a manor. And he that was thus invested in this land by the king, was in respect of such as he infeoffed, called the lord, and such as were infeoffed, were called tenants; lord, in respect of government and command; and tenants, in respect of their tenures, and manner of holding under the lord, whom they were to obey.

Lord. But when, or about what time, was this erection of manors?

Surv. As I take it, and as it seemeth, in the time of the Normans; for among the Saxons was no such name as the name manor, yet the thing even in substance was then, for they had demesnes, and services in substance, but the demesnes they called *inlandt*, and the services *utlandt*, so that it differeth only in name, but in jurisdiction little or nothing at all.

Lord. Whereof is it called a manor?

Surv. There is some difference of opinions whence the word manor should be derived; it is in latin called *manerium*, yet a word not used among the Romans or ancient Latins, and therefore to find the *etymon* by it, cannot be; for the word is used among our lawyers, as many other made words are, which have been terms raised by our laws, and are not elsewhere in use; and therefore the nearest way to find the signification of the word, is by the quality of the thing; so that some hold it should proceed of the latin verb *manere*, which signifieth to abide, or remain in a place, as the lord and his tenants did in this, whereof the head house, or the lord's seat was called *berrye*, which signifieth in the saxon tongue a dwelling place; which continueth yet still in Hertfordshire, and in divers other places, and is also taken sometimes *pro castro*, which was also the seat of the lord of some manors. Manor houses were also, and yet are called in some places, halls, as in Essex, and northward; courts and court-houses westward, as in Somerset, Devon, etc., as also manor places; all which are places of the lord's own abode, and therefore it may not unfitly be said, to take name of abiding or dwelling. Some think, and not improperly, that it taketh name of the french word *manemirer*, which signifieth to till and manure the ground; and of the two, I take this latter to be the most proper derivation of the word manor; for thereof are many chief houses of tillage called *predia*, graunges or *fermes*, which word farm is taken of the saxon word *feormion*, which signifieth to feed or yield victual; for in ancient time their reservations were as well in victual as in money, until at length they were turned into money; and some farm rents do yet continue in victual. Furthermore a manor may take name of *mainer*, to govern and guide, because the lord of the manor had the managing and direction of all his tenants within the limits of his jurisdiction. Of these derivations *qualem mavis accipe*: necessity ties to neither.

Lord. These significations of the word may stand all with sense, and much material it is not whence the word ariseth, but the likeliest is indeed that which most agreeth with the property of the thing. But I have within my manors sundry messuages: whence is the name derived?

Surv. Of *meisus*, or *mesuager*, which is as much to say, as *familiam administrare*, to govern a household; for every of the tenants had his family, and of divers of them and of the lord's family did a manor consist.

Lord. Then no doubt, if a man have a thousand acres of land more or less, to him and his heirs, which lieth in one entire piece, not yet divided, it may be divided into parts, as a portion for the lord himself, and some parcels to erect such messuages for tenants to do him service, as he may make a manor where none was before.

Surv. No, sir, for although a man have a competent quantity of land in his manurance, and would convert it to the end you speak of, were it never so great, and could establish many messuages, and could erect whatsoever services, this would not become a manor, because all these must have long continuance, which cannot at this day be confirmed by any private man, but by the King only; but he may have thereby a kind of seignory, a lordship or government in gross over his tenants by contract or covenant, but no manor. No man at this day can create a service or a tenure, or by any means raise or erect a manor: for there must be very lord and very tenant in fee simple, and that of ancient commencement and continuance, or else it can insure no manor. For a man may have demesnes to occupy, and tenants to do him services, and that of continuance, and yet no manor. As if a man that had land, did give part of this land in former time to some others in tail to do him services, here are demesnes in the donor, and services in the donees, and a tenure; yet because there be not very tenants in fee simple, it maketh no manor.

Lord. Whether are all lands holden of a manor, parcel of the same manor?

Surv. No, lands may be holden of a manor by certain services, the service may be parcel of the manor, and yet the lands not.

Lord. But may not this land be made parcel of the manor at this day?

Surv. By no other means but by escheat, for if the land fall unto the lord by escheat, then it comes parcel of the manor; for then is the service extinguished, and the lord cometh in place of it.

Lord. May not a man purchase land that lieth near his manor, and annex the same, and make it parcel of the manor, though it held not of the manor before?

Surv. Foreign land, newly purchased, though it lie within the precincts and bounds of the manor, cannot be annexed, though the tenant thereof be willing to do his services there; for this is in nature of a new creation of a tenure, which at this day the law will not admit, only the King by his prerogative may.

Lord. What, if it were tied unto the lord of a manor for the payment of an annuity, is not the annuity then parcel of the manor? And if that land be purchased by the lord, and thereby extinguish the annuity, doth not that land come in place of the annuity, and so become parcel of the manor, as the land you spoke of before, which, by the escheat, ran in place of the service?

Surv. The case is not alike; for the annuity was not parcel of the manor, neither can it be by such means as you propound by the way of mortgage (22 *Edward* 4, *c.* 44.) But in another sort it may; as if a manor be to be divided into sundry parts, and because the parts fall out unequal in value, there must a rent or annuity be apportioned to make up the value, which rent becomes parcel of the manor (22 *Li. Ass.* 53).

Lord. If the manor be divided as you say, and a rent allotted to one part, how can the rent be parcel of the manor? for as much as in my understanding, the manor becometh by this partition, to be no manor; for if there can be no addition to a manor, there can be no division of a manor, and yet the manor to continue still a manor.

Surv. Yes, sir, of one manor may be made divers at this day.

Lord. How, I pray you?

Surv. If a manor descend to divers partners, and they make partition, and every one hath demesnes and services, every one hath a manor, and every one may keep a court baron (26 *Henry* 8, *c.* 4).

Lord. What if a man make a feoffment upon condition of parcel of his manor, or do grant a lease to another for life of part, or do entail part, are not these parts still parcels of the manor?

Surv. If parcels of a manor be once thus severed, they immediately become no parcels thereof; yet may they all revert and become parcels of the manor again, as if the condition of the feoffment be broken, if the tenant for life die, or the limitation of the entail discontinue for want of heirs.

Lord. Then a man may say, that though such land be not, yet the reversions are parcels of the manors.

Surv. So it is intended.

Lord. Well, you have reasonably well satisfied me in these points, yet would I gladly have some further satisfaction of some other matters, touching the state and profits of a manor.

Surv. I would be willing to do my best to content you, but you partly hinder me of other business. What else would you know? I wish brevity.

Lord. It shall be so, neither shall you lose your labour; for I mean to use you, if my future satisfaction be answerable to this former,—may every manor keep a court baron?

Surv. Every manor in the beginning, no doubt, might keep a court baron, and so it may at this day, unless the manor be so dismembered, as it wanteth that which may warrant the keeping thereof; for if all the freeholders of a manor do escheat, or all but one, the manor is then disabled to keep a court baron, for the court cannot be kept without suitors, which are the freeholders (35 *Henry* 1).

Lord. Then, methinks, the manor loseth the name of a manor; for if it lose the quality, it is not the thing; no more than a log that had fire can be said a fire-log, when the fire is extinct (*Fitzh. c.* 3).

Surv. It is true, it becomes no manor, but a seigniory, having no power to keep a court baron.

Lord. An ignorant Surveyor, I see, may be easily deceived, in terming that which is no manor, a manor; and that no manor, which, indeed, is a manor. But satisfy me in this one thing:—A man having two manors lying together, and the one of them is decayed, and hath lost its power to keep a court baron, and the lord is willing to have the tenants of both these manors to do their suits and services to one court, namely, to that which standeth yet in force, and that methinks were good for the tenants to ease them, and it would preserve the lord's right without prejudice to any, for then one homage would serve both, and both serve as one, one bailiff, and other officers, as if it were an entire manor.

Surv. Yet this cannot be, for this union of the manors cannot extinguish their several distinctions, for they will be still two in nature, howsoever the lord covet to make them one in name; and the more powerful manor hath no warrant to call the tenants of the decayed seigniory; but every act done in one to punish an offender, in the other is traversable; and, therefore, it is but lost labour to practise any such union. If it be considered by such as are forced to service in this kind, they may refuse it; yet if they will voluntarily submit themselves to such a novation, and the same be continued without contraction, time may make this union perfect; and of two distinct manors in nature, make one in name and use,—and I do not think but such there are.

Lord. Then is there, as it seemeth, no means to annex two manors in one, howsoever necessary it were both for the lord and tenants.

Surv. Yes, sir, two manors may become as one, if one manor do hold of another, and it escheats to the lord; the escheated manor may be annexed, and united, and of two distinct manors become one, if the lord will, in use.

Lord. I am answered in this point, and it standeth with more reason, indeed, than the former; now, I pray you, tell me what things do properly belong to a manor?

Surv. There do belong to a manor, lands, tenements, rents, and services, as I shewed you before in part, which are a parcel in demesnes, and parcel in service.

Lord. But speak, I pray you, something more at large of every of these; and, first, tell me what demesnes are?

Surv. Demesnes are all such lands, as have been time out of the memory of man, used and occupied in the lord's own hands, and manurance, as the site of the manor-house, meadows, pastures, woods, and arable land, that were reserved for the maintenance of the lord's house from the beginning.

Lord. This, then, is that you call parcel in demesne; what is that you call parcel in service?

Surv. All those lands, tenements, and hereditaments, which yield rents of assizes, as rents of freehold, copyhold, or customary land; all which are parcel of the manor, yet no demesnes.

Lord. But is not all customary land, copyhold land? Why then make you a distinction between copy and customary?

Surv. All copyhold land is commonly customary, but all customary is not copyhold; for in some places of this realm, tenants have no copies at all of their lands or tenements, or anything to shew for that they hold; but there is an entry made in the court-book, and that is their evidence, and this especially of the ancient duchy land of Cornwall, and other places.

Lord. These tenants then may be called tenants by court-roll, according to the custom of the manor, but not tenants by copy of court-roll.

Surv. It is true, but they are held only a kind of conventionary tenants, whom the custom of the manor doth only call to do their services at the court, as other customary tenants do.

Lord. The word *convenire,* whereof they be called conventionary, doth, as I conceive, import as much as to call together, or convent, although some would have the word conventionary to come of *conventum,* of covenant,—namely, to be tenants by covenant,—but the former is more probable. But what say you to the rents of assize? What mean you by assize?

Surv. Truly, for my part I take it to signify set in certainty; for these kind of rents are as in the beginning, neither risen nor fallen, but do continue always one and the same; and only they, and none else, can be properly called rents of assize.

Lord. I think you take it rightly; and are all rents of one kind?

Surv. No; there are properly three kinds,—as rent-service, rent-seck, and rent-charge.

Lord. These terms are strange to me, though I be lord of many manors; and, no doubt, I receive rents of every of these kinds; but how to distinguish them, I cannot tell. And whether I have been abused by mine officers or no, I know not; for they never told me of these many kinds of rents; and, therefore, let me intreat you, for my satisfaction, a little to explain their several natures?

Surv. These several rents are paid upon several considerations, and have several grounds and commencements, and are diversely to be levied and recovered if they be denied. That which is called rent-service, is so called because it is knit to the tenure, and is as it were a service, whereby a man holdeth his lands or tenements: as, where the tenant holdeth his lands, by fealty and certain rent, or by any other service and certain rent, the rent is called rent-service; for, as the service followeth a tenure, so the rent followeth the service. And if this rent be behind, the lord of common right may enter and distrain for it. And if the lord cannot find a distress in two years upon the land of rent-service, he may have a writ, called *Cessavit per biennium* (*Sta. de West.* 2. *Ca.* 21), and recover the land. The rent-charge is so called, because when a man granteth any land, whether it be in fee-simple, fee-tail, for life, for years, or at will, and in his deed reserveth a rent, with clause of distress for non-payment, by virtue of this clause, the land is charged with payment of the rent, by express words, and by force of it the lord may distrain for his rent behind. And it is to be noted, that if a man grant land under a rent-charge, and after taketh to himself some of the land, he extinguisheth the rent. Otherwise it is in a rent-service, for there the rent shall be apportioned.

Lord. This kind of rent is at this day, I think, most common; for few will grant land, but they will make such provision, that the land shall stand charged with the rent.

Surv. It is true, for at this day there can be no rent-service raised, because it cannot be without a tenure, which cannot be at this day created.

Lord. What is that you call rent-seck?

Surv. It is a bare rent, reserved upon a grant, wherein there is no mention made of charging the land by distress, and it signifieth *redditum siccum,* a dry rent, for the recovery whereof the land is not charged, and so no distress lieth against it; but being once seized of the rent, and being after detained, he may have an assize, otherwise he hath no remedy.

Lord. Few such rents are now a-days, for a man had need to make all the provision he can to secure his rent, and yet he may be driven to try his uttermost means to recover it. But you have satisfied me, also, touching these rents; now let me entreat you to shew somewhat of other things incident unto a manor, by which the lord receiveth profit or prerogative.

Surv. Profits may arise by infinite means and ways out of a manor to the lord, but all manors yield not profits or commodities alike, neither in nature or value.

Lord. I think, indeed, all manors are not alike profitable to the lord, neither hath every manor like means; yet I desire to know, for my experience sake, what may grow out of a manor, that I may the better look into the natures and qualities of such as are under my power and command.

Surv. If you have a manor, or manors, there is (as I said before) a court baron at the least incident thereunto, and to some a leet, or law-day, which is called the view of frank pledge, by which courts do grow many and divers perquisites and casualties,—as fines of land, amercements, heriots, reliefs, waifs, estrays, forfeitures, escheats, profits growing by pleas in court, and such like.

Lord. You may do well to show me, though briefly, what every of these former things do properly import; for to tell me the names, and not the natures of the things, is, as if I should know there is a sun, but whether he give light and heat, to be ignorant. Therefore, before you pass further in any discourse, shew me how fines of land do arise unto the lord, and what amercements are, and the rest.

Surv. Fines of land are of sundry kinds, and yet properly and most especially they arise of copyhold or customary lands and tenements, which are in divers manors of divers kinds: for there are customary lands, which are called copyhold of inheritance, and they are such as a man holdeth to him and his heirs, according to the custom of the manor, at the will of the lord. When such a tenant dieth, and the heir cometh to be admitted (if the custom of the manor bear a fine certain), he giveth but the accustomed fine; if it be uncertain and arbitrable, he agreeth and compoundeth with the lord, or Surveyor, or steward, for the fine. Some hold customary land for lives,—as for one, two, or three lives,—whereof the fine is always at the lord's will, as is also the fine for years. There are also fines for licenses of surrenders of customary land, and for alienation also of freehold land, and these are called fines, which signifieth as much as a final composition; and when the fine, which is the end of the contract, is answered, all but the yearly rent during the term agreed upon is paid. These and such like sums of money raised at a court baron, are parcel of the perquisites of the court, as are all amercements, which are sums of money imposed upon the tenants by the steward, Surveyor by oath, and presentment of the homage, for default of doing suit, or for other misdemeanors, punishable by the same court, infinite in number and quality.

Lord. Whence taketh the word amercement name?

Surv. Of being in the lord's mercy, to be punished more or less criminally, at the lord's pleasure and will. It is, no doubt, a borrowed word, as many other words used in our common laws are: for he that is amerced, is said to be *in misericordia*, that is, in the mercy of some body.

Lord. These words may be understood by use, and by the manner of the use of things; but he that should seek the *etymon* among the latins, of the substantive *amerciamentum*, and the adjective *amerciatus*, might seek long, and be never the nearer. But, I perceive, we must take it as our fathers first framed it and left it; I understand what it meaneth in our common sense, and that sufficeth.

Surv. Other words, not a few, in like sort to be understood, we find in use amongst us, which, doubtless, the Romans never knew: and yet they that have to do with the things wherein they are used, understand the meaning, although their derivations be strange, as amongst others, it is questionable whence the name of a heriot may be derived.

Lord. That would I be glad to learn, for I have to do sometimes with heriots; but because I know not why they are so called, what they be, how, where, when, by whom, and for what they should be answered, I do fear I am sometimes abused.

Surv. I may tell you as I have heard, and of myself conjectured, whence the word cometh; but I have no certain authority for it. It may be said, and most likely it is, that it should come of the word *herus*, a lord and master, and *heriotus*, belonging to the lord. And it was in the beginning a thing for the wars, as the best horse a man that died, had at the time of his death. And the saxon word *newges* had the same signification that the word *heriotus* hath, and importeth a thing pertaining to the wars; which was, a horse trapped, or a spear, or armour, or a sword, or some such military weapon, which was parcel of the tenant's service due to his lord; and if such a tenant had been slain in the wars in the company of the lord, he had paid no heriot. *Si quis in exercitu, sive in regno, sive extra, pugnans coram domino, mortem oppeterit, ei condonatur et remittitur heriotus* (19 *Henry* 7, *c.* 15). Whereby it seemeth, that his service in the wars belonged unto the lord, and death being the uttermost end of his service, he had done as much as his service bound him to perform; and after his death, his horse and furniture came in place of the service due unto the lord, and thereof called a heriot, being due unto the lord, *de jure*, after his death, and the remission was of any further heriot of his goods than that which he left behind him at his death in the field, which of right the lord might seize, as it seemeth by these words, *Si quis in curia, sive morte repentina fuerit intestatus mortuus, dominus tamen nullam rerum suarum partem, præter eam quæ jure debetur, herioti nomine, sibi assumitur.* So that it appeareth, that at the death of every tenant, there was due unto the lord of the manor of right this *heriotus*,—a thing appertaining to the lord.

Lord. A heriot is never paid, but after the death of a tenant.

Surv. Yes, in some places, if the tenant surrender, forfeit, or will voluntarily depart from his customary tenement or lands, he shall pay to the lord his best quick good, in the name of a heriot, and in some places a piece of money, in the name of a farewell, or farelife.

Lord. It falleth out in a manor of mine, that divers customary tenements heriotable, are dismembered, and such tenements as in former times could yield unto the lord a good horse, ox, or cow, cannot now yield any quick good at all, because the lands are sold from the tenement, and I lose my right: what remedy have I?

Surv. You must take such a heriot as the tenant deceased hath at his death.

Lord. But the land which belongeth sometimes unto the tenement whereof he died seized, is severed so, as there is no entire parcel in any other man's tenure, above one or two acres; is there nothing due for that at the death of the chief tenant?

Surv. No, surely; for, the lands being lawfully surrendered, whereof the lord cannot but always take knowledge (for it cannot be done without his consent), he cannot pretend to have wrong therein; yet this benefit remaineth to you that are the present lord. You may take the advantage of any quick, or dead goods, which any of the tenants have at their deaths, that hold any of the parcels of the land lately belonging to this heriotable *meese place.* And if a tenant have but half an acre thereof, and have elsewhere more land, within or without the manor whereupon he keepeth any kind of cattle, of whatsoever value, though holden of another manor, the best is yours, wheresoever you can lawfully seize it after his death; yea, although it be upon his freehold, as some say (27 *Li. Ass.* 24).

Lord. I like that well; yet, I promise you, it is more than I thought I might have done, and I have lost much by mine ignorance. But may I not compound with all such tenants as have these parcels, to give for every acre so much money, *nomine herioti?* and may not that agreement bind them and their heirs for ever, being recorded in the court-roll?

Surv. No, sir; you cannot make any new custom, although all the tenants consent willingly thereunto: yet, if such a composition were made and continued, without any contradiction of posterities, time might create a new custom, by prescription, and be good.

Lord. What if a tenant have several heriotable tenements, and die? whether shall he pay one or more heriots?

Surv. He shall pay as many as he hath tenants heriotable.

Lord. But there comes a thing into my mind; I pray thee, if thou canst, resolve me. Whether is the heriot paid, in respect of him that is dead, or in respect of him that is to possess the land after him?

Surv. In respect of him that is dead, plainly; for it is not said, it shall be the best good of him that shall inherit, but of him that died; and whatsoever legacies he gave by his testament, the lord will have his due, howsoever they be answered, and may seize it though it be sold.

Lord. It stands, indeed, by reason. But is there but one sort of heriots?

Surv. There are two sorts; the one called heriot custom, the other heriot service. It is held of some, that tenants in fee-simple only pay heriot service, and not a tenant for life; and this kind of heriot is commonly expressed in the grant, or deed, and the land is charged with the payment, and therefore the lord may distrain, or may seize it; and if the tenant bring his action for the taking, the lord may avow, as for other services. Heriot custom is of another nature, for it is held to be *de gratia*, a mere benevolence, given to the lord by his tenant at the time of his death; and now hath custom confirmed it as a debt due, recoverable by force of justice. Some say, it was first given by villeins and bondmen.

Lord. That needeth not; for if the villein and all that he had were the lord's, of common right, as I have heard it was, what needed the lord to take a benevolence, when he might have taken all at his pleasure?

Surv. You say truly, yet it might be given as a continual future gratification upon their infranchisements and manumission, to be yielded at the death of every such tenant. Divers customs of divers places make divers kind of yielding heriots.

Lord. I know that well; for custom, as is said, is above the law. Now, I pray you, say something touching reliefs; for I take it, that was the next branch of your division of the profits rising of a manor; but, first, whence comes the word?

Surv. Reliefe, in french, is as much as *relevatio* in latin, which is derived of *relevo*, the verb, which is, to raise and set up again; and, therefore, M. Bracton saith, "*Relevatur hæreditas, quæ fuit jacens per mortem antecessoris.*" Whereby it appeareth, that the heir payeth this relief as a consideration and recompense unto the lord, to be raised unto the possessions of his deceased ancestors; for this is all the benefit that the lord hath after the death of his former tenant, having neither the custody of the land, or body of the heir, as in some cases the lord hath of both.

Lord. The difference, then, as I gather, between an heriot and relief is, that the heriot is paid in the name of the tenant deceased, and the relief, in respect of the heir that is to become tenant, after the death of his ancestor, to his possessions; but whether of these is the most ancient?

Surv. Surely, the heriot; for that was given in the Saxon's time, as is proved before, and that especially of things pertaining to war; but the relief came since, by the Normans. And where these matters of war are continued and paid in kind, it is under the name of heriot; but where the Normans made composition, and took money for all, it is called relief; so that it seemeth that both these in the beginning were one, but now become two distinct things, both in name and nature.

Lord. You have before told me how the heriot is; now tell me how the relief is paid.

Surv. The relief is paid after the death, change, or alienation of every freeholder, or of a tenant in ancient demesne. And the relief in some places is the whole year's rent, in some manors two years, and in some places half a year's rent, as the custom of the place permitteth (19 *Henry* 7, *c.* 15); in Cornwall, in many manors, they pay for relief for every penny, five-pence; and if the relief be not paid, the lord may distrain of common right.

Lord. You have said enough of reliefs, now speak of the rest; and, as I remember, the next after reliefs was waifs—what are they?

Surv. Waifs, or waived goods, are goods or chattels of what nature soever, stolen, and, in the fugacy of the thief, he leaves them behind him for want of convenient carriage or conveyance, being pursued; and wheresoever such goods are, they are the lord's of that manor or liberty wherein they are found, if the prerogative of the manor will bear it; for every manor will not carry them, but such as have it by grant from the King.

Lord. Whence cometh the word waif?

Surv. The goods thus stolen and left behind the thief, are called in Latin, *bona*, or *catalla waviata*—a word which our common lawyers only use, and the signification is gathered by the use; for, I think, none that is a stranger to the terms of our common laws, be he never so well seen in tongues, can say this word signifies the thing for which it is now taken.

Lord. Well, then, as long as we understand the meaning by the use, it sufficeth, without further examination or disputation about the word itself. But how is it to be proved stolen goods? for it may be as well casually lost as feloniously stolen.

Surv. Therefore, when any such thing is found within a manor, the bailiff or other the lord's officer, seizeth it to the lord's use, as a thing wherein at the instant no man claimeth property. And if it be not evident by the pursuit of the thief that it was stolen, it is proclaimed and presented the next court, and found by the jury of what nature it is, and that the property is in the lord: and because these and estrays are spoken of at large at every court baron by the steward, no man can pretend ignorance of them; therefore I will omit to speak any more of them. But a little of forfeitures; though, no doubt, you being lord of many manors, know right well what they are, and how they grow; and the tenants, no doubt, could wish you and other lords knew less than generally you do, how and when they happen.

Lord. Tush; if there were no penalties, men would commit offences without fear, and if there were no forfeitures for abuses done against lords of manors, tenants would too boldly make wastes and spoils of the lord's inheritance, without regard of law, love, or humanity; and, therefore, let me hear your opinion what forfeitures are, and for what causes lords of careless tenants may take advantage of forfeitures, who may omit and forgive as they see cause.

Surv. I know many lords too forward in taking advantage of forfeitures upon small occasions, and if manifest cause be given them, they show little compassion. And if I knew you were a man desirous to take advantage in this kind, I would be sparing to discover anything tending to that liberty; for, I well conceive, that the law did not so much provide to enrich the lords of manors by their tenants' forfeitures, as to keep tenants in good order, and to restrain them (with fear of losing their tenements) from rash and wilful abuses; as the statutes of the realm, we see, have heavy penalties, but seldom *summo jure* exacted. And, therefore, in all forfeitures, there are divers circumstances to be considered, as, whether the tenant did it ignorantly, negligently, or as constrained through necessity. In these cases, whatsoever law in extreme justice alloweth, a good conscience forbiddeth to take advantage, though the second be worthy to suffer some smart; for negligence cannot be excused; for nature itself teacheth beasts, and they, in their manner of living, use a kind of providence. But if the forfeiture be committed wilfully or maliciously, it deserveth, in the first, little, and, in the second, less pity. Yet, where a good mind is, there lodgeth no revenge or covetous desire. And where neither of these are, there all extremities die. Yet I wish, that in these last two cases, the offenders should be punished more *in terrorem*, for example's sake, than to satisfy the greedy desire of a covetous landlord, who (though he may say, he doth no more than the law warranteth) doth yet strain a point of Christian charity, by which men are bound to measure all men's cases by a true consideration of their own. So shall he that is lord of much,

and of many manors, looking into the law of the great Lord, of whom he hath received and holdeth whatsoever he hath, find, that himself hath committed a forfeiture of all, if this high Lord should take advantage of all the trespasses and wrongs he hath done against him.

Lord. You are out of the matter, whereof your talk consisteth. I desire you not to tell me, how far I may take a forfeiture by a good conscience, but what a forfeiture is; and refer the taking and leaving the advantage, unto such as have the power to punish or forgive.

Surv. So must I, when I have spoken all I can. But I hold it not the part of an honest mind in a Surveyor, to be an instigator of the lord's extremities towards his tenants; though, I confess, he ought to do his uttermost endeavour to advance the lord's benefit in all things fit and expedient; yet ought his counsel and advice to tend no further than may maintain obedience in the tenants towards their lords, and love and favour of the lords towards their tenants, which being on all sides unfeigned, neither of them shall have just cause to complain of, or to use rigour to the other; for it is not the actor himself of any extremity, that is only to be reproved, but the abettor thereunto; and if I wist that any lord, who shall require the use of my poor travails, would expect more at my hands than the performance of my duty with a good conscience, I had rather leave than take the reward for such a travail. Neither do I find that you, howsoever you reason of this point, will commit any act toward any tenant you have, that may not be justified by the law of love; there I leave further to persuade or dissuade you herein. And, as touching the matter and manner of forfeitures, I pray you understand that they be of divers kinds, and divers ways committed; for in some manors it is lawful to do that which in others incurs a forfeiture. Forfeitures grow either by breach of a custom, as in customary or copyhold land, or of a condition or promise in a lease or grant; of which last the tenant cannot say he did not think it was so, because the meaning is expressed in his deed; but of the former, silly men may be in some sort ignorant, if they have not a custom-roll among them to lead them. But, for the most part, causes of forfeitures are apparent, and known of all within a manor; as, nonpayment of their rent; not doing his service; felling of trees upon his customary land, where custom inhibits it; letting his customary tenement fall down; alienating his copyhold land without the lord's license; committing waste; and such like; which, as I said before, are not alike in all places; and therefore it is most convenient that the customs of every manor were known, and the tenants made acquainted with them, that when question groweth for any cause of forfeiture, they may not say they knew it not; for lords commonly know better how to take advantages of such casualties, when the tenants know how to avoid them.

Lord. You speak that is reason, I confess. But may a lord enter immediately upon a forfeiture?

Surv. The forfeiture must be first presented by the homage at the next court holden for the manor, and there found and recorded, and then hath the lord power to show justice or mercy. It were inconvenient that the lord should be judge in his own cause, and his present carver of things doubtful. And therefore hath the law ordained, in all controversies, even in these inferior courts, a just manner of trial by jury.

Lord. May none but copyhold tenants forfeit their land?

Surv. I showed you before that tenants, by deed indented for life or years, may forfeit their estates; but that is by covenant or condition expressed in the deed, according to the prescript agreement made, and interchangeably confirmed between the lord and tenant.

Lord. What is an escheat? for, as I remember, that followeth in your formerly-recited perquisites of court.

Surv. Escheat is where a freeholder of a manor committeth felony, the lord, of whom his land is holden, shall have his land, and that kind of forfeiture is called escheat.

Lord. The lord may then enter immediately into this land, because the law having tried the felony, it casteth the land upon the lord.

Surv. The King hath the use and waste thereof for a year and a day, and then cometh it unto the lord and his heirs for ever.

Lord. Is this all the causes of escheats?

Surv. Escheat may also be where a freeholder, tenant in ancient demesne, and a customary tenant of inheritance, dieth without heir general or special, and none of the blood coming to claim the same, it falleth unto the lord by way of escheat.

Lord. This, then, is immediately the lord's, and the King hath no part or time therein, and without any farther ceremony, he may enter and dispose of it at his pleasure.

Surv. It must be also first found and presented by the homage of the manor whereof it is holden, and after proclamation made to give notice unto the world, that if any man come and justly claim it, he shall be received; the homage then finding it clear, doth entitle the lord thereof, as a thing escheated for want of an heir.

Lord. You speak of an heir general or special, what difference is there?

Surv. The heir general is of the body of the deceased, and the special, of his blood or kin.

Lord. So have you satisfied me thus far; now what say you to the pleas of court? for I remember it is part of that you before spake of.

Surv. It is true; they are parcel of the perquisites of court.

Lord. Whereof cometh the word perquisites?

Surv. Of the word *perquiro* (as I take it), which signifies to search for, or to inquire diligently, as, also, to get or obtain.

Lord. It may well be so; for these things before rehearsed under the name of perquisites, are all casual, and not at all times alike; and therefore may be called *perquisita*, things gotten by diligent inquiry. And to that end, so many things are given by the steward to the jury of a court baron and leet in charge, that they should diligently inquire of them, find them, and present them; and yet scarcely one of forty, of the several things wherewith they are charged, are found by the jury. And some things happen at one court, that happen not again in twenty courts after; and, therefore, are also called casualties, as happening now and then, as I conceive it, having little experience in them.

Surv. Yes; it seems you have the better part of experience, namely, the receiving the profits that any way happen within the manor; some know the same, but as appertaining to others, not to themselves. Of this nature also are the profits that arise by pleas of court, which, because they are divers, and do diversely arise, there needs no long relation of them.

Lord. Are there no other perquisites of court, but such as you have already remembered, nor other profits arising to a lord of a manor?

Surv. There be many other profits that may grow also unto a lord of a manor; yet they are not certain, nor in all manors alike.

Lord. Then are they also casual; and may be called also perquisites of courts.

Surv. Casual, but not perquisites of court; yet some of them may be called *perquisita*, in some sense, because they be gotten by search and inquiry, as those that are hidden in the earth: treasures, which as long as they lie unknown, benefit not the lord; but when they are formed they are called treasure trove, as silver, gold, plate, jewels, and such like, beforetime hidden, which appertain unto the lord. So do minerals of lead, tin, copper, and such like; and quarries of stone, free-stone, slate-stones, marking stones, and all such, which may lie long undiscovered. As may also coal, lime, chalk, and such like, for which, search being made, are haply found; yet, because the benefit is uncertain upon the present, and what continuance and vent it may afford, they may pass under the name of perquisites and casualties; as may also fishing and fowling, unless the lord can bring the same to be of a certain continuing rent, then are they no more casual during the grant, but are in nature of other rents,

certain. And of these kinds, are infinite other things, incident to some manors, but not to all. As the profits of fairs and markets, wood sales, sales of heath, flags, and turbary, pannage, and such like. All which are in themselves uncertain, as touching the value, unless they be turned into a rent certain.

Lord. That, I take, is the surest way for the lord; for he that commits the dispensation of these uncertain things to bailiffs, unless they be very honest indeed, may make their bailiffs rich, and raise little profit unto themselves, as I am taught by experience, especially dwelling afar off from my manors.

Surv. Yet the lord must be wary how he lets these casual things, before he know what they are, how they rise, and what profit they may yield, how they will continue, and to whom; and upon what conditions he grants them. Otherwise he may be overtaken and much abused; for a secret benefit once let, cannot be revoked at pleasure.

Lord. You may, indeed, call these things secrets, because their validities are not suddenly apprehended or found, being in themselves novelties, which sometimes come short, sometimes exceed the hope a man hath in the value which may grow by them.

Surv. Therefore, I say, it behoveth the lord, to whom such casualties shall befall, first to make due and diligent trial by men, both of trust and experience, what may be made of any such thing by the year. For such is the wary dealing of some, that have the guiding of things of this casual nature, that they will observe the conditions and qualities, circumstances and value to themselves, and disable the thing, and extenuate the value to the lord, to bring him out of conceit with the goodness and validity thereof, to the end they may obtain a grant; as hath fallen out in many things and to many men, whose future profit of the things thus achieved hath approved the lord to be much abused. This I know by experience in the grant of a coal mine, which, as long as it was in the lord's hands, it yielded a small yearly revenue, until he, that managed the same, got a grant of the lord, and then the profit was twice quadrupled by the lessee's own confession. The like of a salmon-fishing, wherein the lord lost two parts in three, and yet at the time of the letting made to believe it was hardly worth the rent; yet would I wish the lords of manors in these casual things to be contented, after true trial made, to grant the same for a reasonable rent, though the lessee gain; for the travail and hazard in these uncertain things deserve some favour; for in receiving a rent is little toil, and as little danger, but in these kinds of things is uncertainty of profit, and assured care and labour.

Lord. I observe, by your discourse, that you seem very indifferent between the lord and tenant: I mislike it not, so you stand firm to the lord that employeth you, as right and equity requireth.

Surv. Every profession, sir, hath its defects: if they be voluntary or wilful, they are utterly intolerable, for they be either for affection or lucre. Negligent defects cannot be excused, for they proceed of the want of heed and careful industry. But, for my part, I will endeavour to discharge my duty truly, and will wade in the business, both mine eyes opened; but when I consider the lord and the tenants, I will shut them both.

Lord. Will you so? Is that all the care you will have of the lord's benefit, that payeth you for your travail? And shall the tenant be as well respected as he? I think you will hardly prove a fit Surveyor for me.

Surv. If you require other than an upright course between your tenants and you, I reverence your person, but desire not your service; for, know you this, I pray you, that as the land and the profits of it is yours, and your revenues grow by the rents, labour, and service of your tenants, your tenants have as good interest in their tenements for their rent and doing their service, as you (under your correction) have in the manor, according to the quality of the tenures; and that being saved to them, and a good conscience to me, I shall do what you will require.

Lord. It is as much as I desire; for that which I crave of you, is but to observe and report every particular thing within the compass of your survey, whereby I may apprehend truly the full estate of my manor, as behoveth, and what commodities do arise, or may by any means lawfully be raised in the same.

Surv. If a painter should draw your picture, sir, and you having a blemish in your face, or defect in your lineaments of body, would you think he dealt truly with you if he omitted the blemish, and made your parts perfect and straight, being deformed and crooked?

Lord. I know your meaning; I like no such flattery; neither would I he should make a straight leg crooked, but true conformity in all parts.

Surv. So will I, as near as I can; for neither in quantity, quality, or value, will I, for I ought not to be partial; for these are the things wherein injury may be done to the tenants: neither will I, for I ought not conceal or counterfeit their estates, terms of years, lives, covenants or conditions, rents, services, forfeitures or offences; neither whatsoever profits, emoluments, or commodities, that may anywise arise or grow unto the lord. For a partial eye seduceth the heart, and the heart the hand, and the hand the pen, which cannot but witness against a corrupt entry of these collections, many years after the Surveyor is in his grave.

Lord. Thou speakest as an honest man, and I mislike thee not, if thy words and thy works agree. And seeing we are grown thus far, I pray thee make an end of thy whole discourse, and tell me what else appertaineth to a manor.

Surv. I have already declared the most. But manors much differ in their profits. For a manor of small quantity of land, and few tenants, may be more beneficial to the lord than a far greater.

Lord. How may that be?

Surv. Divers lordships yield extraordinary commodities, some under the earth, some of the earth, some above the earth: as tin, lead, copper, coal, stones, millstones, and such like, found under the earth, which every manor hath not.

Lord. But these are chargeable commodities to get.

Surv. So is the lord of a manor at no cost in planting, ploughing, setting, or sowing them.

Lord. That is true, but commonly the land is barren where these things are found; and therefore it is a great work of Divine Providence to yield such a commodity from under the barrenest soil, to supply the want thereof in places more fertile, of other things most behoveful for the relief of man. And yet in many of these barren places, groweth by the diligent man, corn in abundance, as the Psalmist saith: "A handful of corn shall be sown upon the top of the mountain, and the fruit thereof shall shake like the trees of Lebanon." (*Psalm* lxxii, 16.)

Surv. Where diligence is and the fear of God, there, no doubt, God blesseth the labours of men, and "watereth even the highest mountains from his chambers." (*Psalm* civ, 13.) For when Israel turned to God from their idolatry, he promised, by Ezekiel, (xxxvi, 9) that "their desolate places and high mountains should be tilled and sown." "But he maketh a fruitful land barren, for the sins of them that dwell therein." (*Psalm* cvii, 34.) So that, whether God send his blessings under the earth, upon the mountains, or in the valleys, whether in grass for cattle, in herbs for the use of men, whether in wheat, oil, or vines, he truly entitleth none unto them but such as fear to offend him, and show thankfulness for them.

Lord. Though these words digress from our present matter in hand somewhat, yet it is good that both lords and tenants should know and acknowledge indeed, from whom all these good things do proceed; for although they come, some from under the earth, some of the earth, and some above the earth, they be not yet the gifts of the earth, but of God, that hath provided the earth to bring them forth to our use. But what mean you by the things of the earth? come not these of the earth?

Surv. Yes, I confess it; but some things are more perfect of themselves than others. But such as, by an extraordinary working of man's art, are made of the earth, I term things of the earth, and they also rest to the benefit of the lord of that

manor where such earth is found; as the earth whereof alum, copperas, salt-petre, glass, or other such is made, together also with fuller's earth, brick, tile, and potter's clay, which are not common.

Lord. What else is there to be considered touching the things incident to a manor?

Surv. Nothing, sir, that I now remember.

Lord. Well, I have heard all thy discourse with patience; and indeed my desire was to hear thee in these things, and I mislike not anything in thy whole relations. But who comes yonder?

Surv. I take it, it is your tenant that lately departed from us.

Lord. So it is; I will leave you two together; fare you well; you know the places where mine occasions will draw you, and in the mean time I will make you a warrant to go in hand with it.

THE END OF THE SECOND BOOK.

THE THIRD BOOK.

THE DIALOGUE BETWEEN A FARMER (ALSO THE BAILIFF) AND A SURVEYOR.

Farmer.

YOU are happily met here again, sir; have you ever since had conference with my landlord?

Surv. Yea.

Farm. He is a man of good understanding, and very inquisitive of things of profit; and yet, to tell you truly, he is a good man to his tenants.

Surv. Love him then, for such deserve love.

Farm. He is beloved of his tenants, indeed; for they will go, and ride, and fight for him.

Surv. It is the part of good tenants, and an argument of a good landlord. But fare you well, I cannot now stay; I have been long letted by your landlord and you, and I have present business.

Farm. Are you presently to undertake the survey of my landlord's lordships?

Surv. I am now going about it.

Farm. I think it be in your choice where to begin; let me, therefore, entreat you to begin with Beauland, a manor of his here at hand, whereof I am both tenant and bailiff; and therefore I will and must attend you, and yield you my best aid, both by my travail, information, and records of the manor.

Surv. Keep you the lord's records?

Bailiff. The key is in my keeping that leads to the chest, but the key of the chest is in my lord's keeping: but I will send for it, that you may have the full view of the evidence.

Surv. So it behoveth: for a manor can never be aptly or truly surveyed without the view of the evidence, which discover from whence the original interest is derived, how it is holden, by what tenure, the customs, and other such necessary points, as not being known, the survey (though in some things may be perfect) cannot be absolute.

Bailiff. But I remember some of the evidences of this manor are in french, and some in latin, so ancient as few can read them.

Surv. They are so much the more certain, by how much the more ancient. And it is a great defect in a Surveyor if he cannot understand the french deeds, nor read nor understand the most ancient records.

Bailiff. Indeed it is necessary a Surveyor should be able to understand them, though I think few of them do.

Surv. No doubt many do, and all ought; but some lords are too curious in suffering the Surveyor to peruse them, wherein they prejudice themselves; for if they will not trust a Surveyor to see the evidence, let them never permit him to survey their lands. Is this a large manor?

Bailiff. It is spacious in circuit, and of great appearance of tenants; full of divers commodities, both under and above the earth, as also of fishing and fowling, and beareth not the name for nought: for the manor is fair, and very commodious.

Surv. Be you then my guide, and now to our business. You are bailiff, take this precept, and summon the tenants to make their appearance according to the purport of the same.

THE FORM OF THE PRECEPT.

BEAULAND MANERIUM.

These are to will, and in the name and behalf of A. B., the lord of this manor, to require you to give notice and warning unto all and singular the tenants of the same manor, that they, and every of them, make their personal appearance on Monday next, being the 10th of this instant June, at the place where the lord's courts of this manor are usually kept; and also to warn them, and every of them, to bring with them all such deeds, copies, leases, and other evidences, whereby they or any of them do hold, or claim to hold of the lord of this manor any land, tenements, or hereditaments; and that they then and there shew, or cause the same to be shewed unto the lord's Surveyor, at the court then and there to be holden for that purpose, and to give their further attendance as occasion of the service shall require. Whereof fail you not, etc. Dated the 3d of June, in the fourth year of the reign of our Sovereign Lord James, by the grace of God, King of Great Britain, France, and Ireland, etc.

Per I. N. *Supervis.*

To the bailiff of the manor of Beauland, or to his deputy.

Commonly the lords of manors do direct their own letters of warrant unto the tenants, unless the Surveyor be a known Surveyor by patent, and performeth the service when and where he thinketh most fit for the lord's use.

The order of a court baron being performed (for a Surveyor hath not power to administer an oath *ex officio*, unless he be a Surveyor by patent, or by commission, out of the Chancery or Exchequer, Duchy Court, Court of Wards, or such like) by a particular steward, or by the Surveyor, who for the time may supply the steward's office; and the charge of the court baron ended, the Surveyor may proceed to his admonition and charge, to the effect following:

First, taking note of the names of every tenant, both freeholder, copyholder, lessee, and tenant-at-will, in a paper, and a jury for the survey being empanelled, (after they be sworn,) the Surveyor may premonish them to the effect following, in words according to his own discretion:

You that have been here presently sworn to perform your uttermost duties, in all things that are and shall be given to you in charge, do, or at least you may conceive, that as the court baron (the charge whereof you have already heard) is with you ordinarily twice a year, and (if the lord will) every three weeks: this kind of court, which I have now to admonish you in, tending to the survey of the manor, happeneth not (perchance) in the time of man's age, though the lord hath power, and (no doubt) occasion to keep it oftener. You must, therefore, show yourselves so much the more diligent in this, by how much the more

seldom you are troubled therewith. And it behoveth you to call to mind, what by oath you have assumed to perform, namely, all that shall be given you in charge, whereof part hath been delivered unto you already: which being so ordinary amongst you, it must needs be more familiar than the things you have seldom heard of. And for that this business of survey stretcheth a little further than the court baron, let your due attention and examination, and faithful presentments, witness your true affections to the persons and ends to which the purpose of our present meeting at this time tendeth. The particulars inquirable are many, and of many kinds; but the persons and ends few. The first is God, in whose presence we all stand; "who loveth truth from the inward parts," that is, when the action and the will concur, and hateth dissimulation. The second is the King, whose we all are, under God; whose laws we are to follow, as well in this business as in any other: for that it tendeth to the seeking and settling of truth (the mother of true peace) between you and your lord, in giving both to you and him what is equal and just. The third is the lord of the manor, whose you are under God and the King; and therefore requireth at your hands, at this time, equal dealing, neither to discover for malice, nor to conceal any thing for favour to either party. The fourth is yourselves, whom you can in no better sort befriend in this action, than to keep your hearts and lips pure in concealing or uttering: for there is as great a danger in concealing truth, as in uttering a falsehood: and there is no such burden, as the burden of a guilty conscience, which is laid on no man but by himself. And lastly, the persons to be considered in this business are your posterities, whom your true or false relations will either help or hurt. The ends whereunto it aimeth are, first, to explain unto the lord of the manor what is his by the examination of your estates, rents, and customs, and to establish you in all things that are rightly yours: both which being duly found and duly recorded, cannot but preserve amity between you and your lord, which should be the principal end of all endeavours. And sith "God is the first and the last," and will be present in the beginning, in the middle, and in the end of all your consultations, and will be a witness for you or against you, even in your most secret counsels, set him before the eyes of your hearts: so shall you tremble to conceal truth or utter falsity, whether it be with or against yourselves or dearest friends, yea, or the lord of the manor himself; whose purpose in this service is, that the manifest truth might be confirmed, the hidden revealed, and errors abandoned. And all this lieth in you, and at your hands it is required to search, and by searching and examination to find out; and found, to deliver and present the whole, and not a part of your sincere knowledges: for from your mouths must that be taken and had, which must be recorded for the direction of your posterities, as a perpetual glass, wherein the estates of all the particulars within this manor may be at all times seen and confirmed: wherein you shall discharge your duty to God, who commands and commends truth: to the King, who by the sword of his justice maintains truth: to your landlord, who desireth only to know and have his own: to yourselves, who by this means shall possess your own in peace: and to your posterities, who by this your travail, diligence, and true information, shall partake of your sincere and faithful service, being enrolled and recorded under your names, to your perpetual commendation; whereas if you delude me, and abuse the lord of the manor that hath sent me, I, by your sinister information, may commit error, and leave it to your posterities by record; yet shall I be free of the wrong, and you shall answer it. And if you should frame any defence against the service, and plead either ignorance or show obstinacy, pretending thereby to stand dispensed of your oath, because you do it not, you deceive yourselves: for the service is so inseparably knit to your tenures, and your tenures to the lord of the manor, as deny or refuse to do the one, you forfeit the other. Howsoever some may say that they are freeholders, and they are customary tenants of inheritance, which in their conceit implieth a kind of freedom, let them not deceive themselves their estates are conditional, as, both by their deeds and copies, they may be easily resolved by these words: "*Habendum sibi et hæredibus suis*" (in the deed), "*ad voluntatem domini, secundum consuetudinem manerii*" (in the copy); in both, "*pro reditu et servitiis inde prius debit, et de jure consuet.*" And because some of you do not (perchance) understand the meaning of these words, of your own evidences, thus they signify, that you are to hold your tenements, to you and your heirs, etc. (being of inheritance), for such rent, and doing such services, as have been heretofore due, and of right accustomed. Is not this a condition? for if you pay not the rent, or if you deny the service, you are at the lord's mercy to be compelled. I do not think, therefore, that any of you, of any discretion, will adventure the loss of his interest for not performing a service so just and reasonable at his lord's command, that tendeth also to his own benefit, and to no prejudice at all to himself or his posterity.

The end, therefore, of all mine admonition is, to move you (being a thing of common right) to show yourselves like unto yourselves, true and faithful tenants unto the lord, concurring all in one mind to do the lord this service in love, and the lord, no doubt, will recompense it with like favour, although there be no recompense due, for that which duty bindeth to be done. By this means you shall confirm your own strengths, by gaining and retaining the lord's kind countenance; and he, again, shall be the more fortified by your true affections towards him: for what a joyful thing is it for lord and tenant to dwell together in unity? Now, having thus prepared you to attention unto the matters of your charge, I will here read and explain unto you such articles as shall be for your instruction, and leave them with you in writing for your better memory; for I know, and have often found, that a bare delivery of many words, and of divers things, (as in the charges commonly given in courts baron and leet,) even to ears well prepared, may be little effectual, less to him that heareth and regardeth not, but least of all to him that will not regard or hear all. Such hearers there are of divine things, but many more of human, of this kind; but were they matters of carnal pleasure and delight, they would be both heard and practised: and therefore I the more move you, to attend unto the things which I now am to deliver unto you.

THE SUBSTANCE OF THE CHARGE OF A COURT OF SURVEY, CONTAINED IN THE ARTICLES FOLLOWING.

BEAULAND MANOR.

1. As, no doubt, you all know, that A. B., knight, the reputed lord of this manor, is the true and undoubted owner of the same, and of all the lands, meadows, pastures, and other hereditaments within and belonging to the same; and that you, and every of you do hold your lands belonging unto this manor of him: if not, who hath the interest and right of the same, to your knowledges.

2. You shall duly and diligently set down, or shew unto the Surveyor in his perambulation of the manor, all the circuit, butts, bounds, and limits of the same, and upon what and whose manors, lordships, lands, and parishes it bordereth on all parts. And whether any confining lord or his tenants, do any where intrude or encroach upon this manor, where is it, by whom, and how much is so encroached.

As for the bounding of the manor, it is fittest to be delivered unto the Surveyor when he treads the circuit, and that the best experienced tenants accompany him for information, and some of the youth, that they may learn to know the bounds in times to come.

3. Whether there be any other manor or manors lying within the limits or circuit, or extending in part into this manor, what are the names of the manors, and who are owners of them, and how are they distinguished from this manor. And whether this manor do any way extend into, or lie within any other manor.

It is often seen that one manor lieth within another, and intermixed one with another, in such sort, as the true circuits, butts, and bounds become confounded; necessary therefore,

it is, that their distinctions should be carefully observed and recorded; for oftentimes one is devoured, or otherwise injured by the other, when lords are remiss, and tenants careless, to bring that to certainty, which is, or may become doubtful. And, especially, where many manors lie intermixed, and one man holdeth land (copy or free) of them all, there oftentimes groweth confusion, unless each part be well butted and bounded; for, though he can say how many acres he holdeth of either manor, yet he cannot distinguish the land, whereby some of the lords cannot but be abused, or the tenants wronged, as it is commonly seen and found, where one tenant holdeth confining lands of divers manors.

4. What freeholders there are within, or do belong unto and hold their land of this manor, what are their names, what land hold they, what rent pay they, by what tenure do they hold, and what service owe they to the lord.

Freeholders are of divers kinds, of divers tenures and services. And the negligence of lords in the due continuance of the substance of this article, hath bred prejudice to many; for, where freeholders dwell out of the manors whereof they hold and pay unto their lords but a small acknowledgment, as a rose, a peppercorn, a gillyflower, or some such trifle; or are to do some service at times, whereof in many years hath been no use, they have not been looked for, neither have their suits been continued for long time, insomuch that they and their tenures have grown out of memory, and their services out of use, and other lords have entitled themselves to the land, and the right lord lost all possibilities of estate, escheat, etc. (*Littleton Ten. Tit. Socage*, c. 5), as common experience maketh more plain, by the daily questions and suits which rise, when profits apparent may grow by any of the former casualties.

And, therefore, it is most necessary to have always a true suit-roll, whereby the steward should, every court, call the freesuitors by name, and to express what rent he should pay, and what services he ought to do; and that at the death of every suitor, his heir, with the land, rent, tenure, and services, would be inserted in his stead. The profit that will hereby grow unto the lord and tenants is manifest; namely, to the lord, the possibility of escheat, relief, etc., and to the tenant, a certainty of whom and how he holdeth; and this roll is to be made by the Surveyor, and to be indented, the one for the lord, the other for the tenants, upon view of every freeholder's evidence and land.

5. Whether any freeholder within or belonging to this manor, hath committed any felony or treason, and hath been thereof convicted, the lord not yet having the benefit of the forfeiture, or whether hath any such tenant died without heir general or special; if so, who hath the present use and possession of the land, and by what right; what land is it, where lieth it, how much in quantity, and of what value.

It is a great defect in a survey of a manor,—which remaineth to posterities, being enrolled or engrossed for perpetual memory,—when the Surveyor doth superficially pass over the observation of the lands of every freeholder, their tenures, quantity of land, the place where it lieth, the rent and services; for upon sundry necessary occasions, the lord is to seek in every of these, and some are worthy, because they love not to be at charge to find out and continue that which is not presently profitable.

6. Whether doth any bastard hold any land belonging to this manor, a sheir unto any, what is his name, what land is it, and where lieth it, and what is it yearly worth.

A bastard, though he be known to be the son of that father that leaveth him the land, cannot inherit *jure hæreditario*, but by conveyance. Neither, if he purchase land in his own name, can any inherit it after him of his supposed blood, unless he be married, and have children lawfully begotten to inherit; because it is *contra formam ecclesiæ*, as appeareth more at large; Merton, c. 9. For a bastard is no man's, or every man's son or daughter. Yet if a man take a wife that is with child by another man, that was not her husband, after the child is born it shall be reputed *mulier*, and no bastard, though it be not the son of the husband.

7. What demesne lands hath the lord within or belonging to this manor, what and how much woods, underwoods, meadow, pasture, arable, moors, marshes, heaths, wastes, or sheep-walks. And what is every kind worth yearly by acre, how many sheep may the lord keep upon his walk, winter and summer, and what is a sheep-gate worth by year, and what is every acre of wood worth to be sold.

Although this article, and sundry other hereafter mentioned, be in substance enacted by a statute made anno 3 Edward I, called *Extenda Manerii*, to be inquired of by the tenants, yet it is the part and office of a Surveyor to see, examine, and judge by his own experience and knowledge, every particular, comparing the jury's presentment with his own opinion; so shall he more truly attain to the true understanding of the things he seeketh, and the more, if he discreetly feel the minds of foreign inhabitants that are ignorant of the cause of this inquisition.

8. What demesne lands hath the lord lying in the common fields of the manor, how much in every field, and every furlong, and what is an acre of ordinary field arable land worth by the year. The like you are to present touching demesne meadow, lying in any common meadow within the manor.

9. Also, you are to present the names of all your common fields; and how many furlongs are in every field and their names, and the common meadows and their names. And what beasts and sheep every tenant ought to keep upon the same, when the corn and hay is off, and what a beast-gate and sheep-gate is worth by year: also, at what time your fields and common meadows are laid open, and how are they or ought to be used. And whether is it lawful for the tenants to enclose any part of their common fields or meadows, without the license of the lord and consent of the tenants.

This article is duly to be considered, first, in setting down in certainty what every man is to keep upon the fields and common meadows; because injury is daily done by some of greatest ability to the meaner sort, in oppressing the fields with a greater number of cattle than according to a true proportion will fall unto their share; which is very extortion, and a punishment is to be inflicted upon the offenders.

Also, enclosures of common fields, or meadows in part, by such as are most powerful and mighty, without the lord's license and the tenants' assents, is more than may be permitted; the reason is, that the rest of the tenants have as much right to every herb and grass within the same, when the corn is off, as he hath that encloseth the same.

Bailiff. But, sir, if they lay it open at Lammas, or at such time as custom requireth, I think he doth neither lord nor tenants wrong.

Surv. Yes; for, first, he depriveth them both of the feed, of as much as his hedges, ditches, and enclosures take; besides, whether is it as convenient for pass and repass of cattle at one little gap or two, as when there is no estoppel at all?

Bailiff. You like not enclosures then?

Surv. I do, and I think it the most beneficial course that tenants can take to encrease their abilities; for one acre enclosed, is worth one and a half in common, if the ground be fitting thereto; and if the wastes and unprofitable commons in England were enclosed and proportionably allotted, it would feed more people by good manurance than any one shire in England.

10. What commons there are within the lordship, which do properly belong to the lord and tenants of this manor, and how are the tenants stinted, whether by the yard-land, plough-land, ox-gang, acres, or rent; how many may every tenant keep after either proportion or rate.

In this the like consideration is to be had as of the former; but that this kind of pasture is called in the statute of *Extenda Manerii* (3 *E.* 1), *pastura forinseca*, foreign herbage

or pasture, because no part of it is proper in any sort to any peculiar tenant, no not to the lord himself, as are the common fields and common meadows. This kind of common, or *pastura forinseca*, is in three sorts: the one is, where a manor or township having and holding their land in severalty, have by consent limited a certain parcel of ground, to lie common among them, and from the beginning have stinted every man according to a proportion between them agreed, and that is commonly by the acre, which the pasture containeth.

Another manner of such kind of common pasture is, where certain waste grounds,—one, two, or more,—lie within the manor or township, and the herd of the whole town is guided and kept by one appointed by the tenants, and at their general charge, to follow their cattle; in which kind of pasture there is also a limitation, or stint, both of the number and kinds of cattle, and this most in the north parts.

A third kind of this pasture, or common feeding, is in the lord's own woods that lie common to the tenants; as, also, common moors, or heaths, that were never arable.

In all the former commons of pasture there should be a certain stint and allotment, both to the lord and his tenants; but in this latter it seemeth that the lord should not be limited, because all these latter commons are supposed his own, and the tenants have no certain parcel thereof laid to their holdings, but only bit of mouth with their cattle; but the tenants ought to be stinted in all sorts of common, lest, as I said before, the rich devour the poor,—for the one can provide sheep and other cattle for the summer, and have enclosed pasture for the winter, or can sell again when the foreign pasture is gone; but the poor cannot do so.

Commons, again, may be distinguished into commons in gross, common appendant, common appurtenant, and common by way of neighbourhood.

Common in gross is where a man by deed granteth unto another common of pasture:—Common appendant is where a man is seized of land, to the which he hath common for such beasts as serve for composting of his land, wherein geese, goats, and hogs, are exempted; and this kind of common is by prescription as an appendix, or addition, only to arable land, and not to any other:—Common appurtenant is in the same nature, but with greater liberty, because it is for all kind of cattle, hogs, goats, etc., as for other kinds. And this common may be made at this day, and may be severed from the land to which it is appurtenant, and so cannot common appendant be:—Common by neighbourhood, is where the tenants of two lords, or more, adjoining, do enter common either upon other with all commonable cattle. But one may not put his cattle upon other's commons; if they do, an action of trespass lies.

11. Whether hath any man to your knowledges encroached any part of the lord's wastes, by enclosure, or adding any part thereof to his own land; present who hath so done, where, how much, and how long it hath continued.

This kind of encroachment is not rare, especially where great wastes and mountainous grounds are, where the lord nor his officers walk not often, and where tenants, for favour or affection, will wink at evil doers; or, for their own private lucre, commit the same error themselves, with hedges, ditches, pales, walls, sheds, etc.

12. Whether hath the lord any park, or demesne wood, which by stocking may turn to the lord's better benefit, by pasture, arable, or meadow; and what is an acre worth, one with another, the stocking; and how many acres is the wood; and what will an acre of the wood be worth; and what will an acre of land be worth by the year to be let, when the ground is stocked and cleared.

Although it be the part of the jury to yield their opinions in this case, yet it behoveth the Surveyor to have so much judgment in every of these points, as he may be able to satisfy himself and his lord, by sufficient reasons, lest he be deceived, and the lord abused, either through ignorance or partiality. And above all, it behoveth the Surveyor to look into the nature of the soil of the wood; for there are some wood-grounds that are good for no other use,—as a dry or cold gravelly ground, whose virtue and disposition may be easily observed by the herbage.

13. Also, you must present the names of all customary tenants within, or belonging unto the manor; what messuages, tenements, or lands, they hold; and what every messuage or tenement is called; what rent it payeth; and what profit ariseth to the lord, by the death of any such customary tenant, or by the death of any freeholder, by fine, heriot, or relief, by the custom of the manor.

Commonly, these customary tenants, upon death and alienation, do pay a fine, which in some places is certain, and in some, even in the most, they are at the lord's will; and in some places they are also heriotable.

Bailiff. In this manor there be some customary tenants heriotable, and some not; how comes that? can there be two customs in one manor?

Surv. There may be so; and the reason may grow by the escheating of a manor, that had in this point a contrary custom to the manor to which it was escheated and annexed; and so the customs of either may hold under one court.

Bailiff. Your reason is good; and I take it, it may also be, that these that pay no heriots, are tenements of a newer erection, and so upon their first grants the heriots were omitted.

Surv. That is not so likely; for that if any such new erections were, they were granted in such form as other tenements, with these words: "*Habendum, etc., ad voluntatem dom. secundum consuet. manerii*"; which words do imply all duties and services which the most ancient tenements are bound unto.

There is also a copyhold estate, called ancient demesne, and the tenants, sokemains, whereof some are of frank-tenement, and some of base tenure. (*Briton.* fo. 165). Tenants of base tenure are they that hold by verge at the will of the lord, and the frank-tenement thereof is in the lord.

It is to be noted, that copyhold lands are very ancient, before the Conquest, in the Saxons' time, who called this kind of land, Folkeland, and their charter lands were called Bokeland.

14. How doth the customary land of this manor, by your custom, descend after the death of an ancestor, to the younger or elder son? And, whether will the custom of the manor allow an entail by copy; and whether doth it bear widow's estate, or whether she may have it during her life, though she marry; and whether may a man hold by the courtesy, or as long as he holds himself widower.

Surely, differences there are in sundry manors, touching the substance of this article.

The custom of some manors is, that the youngest son shall inherit, as in Borough-English; if he have not a son, his youngest brother, — as at Edmonton, in Middlesex. In Ottery St. Mary, in Devonshire, the land, which is customary of inheritance, descends to the youngest son, or youngest daughter.

In the same manor, a man that holds that kind of land in right of his wife, and she die, the husband living, he shall enjoy the land as long as he lives unmarried, though he have no issue by her. The like custom is there in a tenure called Five-acre land, and descends, likewise, to the youngest son or daughter.

In the same manor there is a tenure, called Old-Burton land, which descendeth to the eldest son or daughter, and the wife of such a tenement shall hold, during her life, though she marry. And the husband of a wife, inheritrix of that land, shall hold after the death of his wife, as long as he is unmarried.

The custom of some manors is, that all the sons and all the daughters shall inherit alike, as in Gavelkind.

The custom of some manors is, that if the tenant die

seized of five acres or under, then the youngest son shall inherit, but if above, then all the sons shall inherit.

The custom of some manor is, that neither the wife shall have dowry, neither the husband hold by courtesy. And the custom of some other manor is, that she shall have the third part of the rent,—as at Bushey, in Middlesex,—and no part of the land in dowry.

In some manors, the wife, being a virgin at the time of her marriage, shall have all the copyhold land for her frank bank, whereof her husband died seized. And many such. At Kilmersdon, in Somersetshire, the wife hath widow's estate; and if she marry, she loseth the land; but if she be found incontinent, and come into the next court riding astride upon a ram, and in open court do say unto the lord, if he be present, or to his steward, these, or words to this effect:

> "For mine arses fault, I take this pain,
> Therefore, my lord, let me have my land again"—

She is by the custom to be restored unto it without further fine, doing this penance; the like hath been in Sunning, in Berkshire, and in many other manors. In the manor of Cheltenham, in Gloucestershire, there is a custom, that a man cannot marry his daughter to any man, neither can a widow marry, without the lord's license; and if a man by his wife have never so many children, and die, his widow may marry another man, and he shall carry away all the land after the death of his wife, from all the former children; and he may marry again, be he one hundred years old, with a girl of six or seven years, and she shall carry away the land from all the heirs.

Bailiff. These are foolish and unreasonable customs.

15. Whether there are any customary tenements that are heriotable, dismembered and divided into parcels, to the weakening of the tenement; and who be they that have these heriotable parcels; and what quantity hath every of them.

Although there be no immediate profit can accrue unto the lord by the presentment of the substance of this article, yet it behoveth the lord to know, who be the tenants to any part of the land belonging to an heriotable tenement, because every part continueth heriotable, and draweth unto the lord the best beast of the tenement of such land deceasing, though the land, in regard whereof he payeth it, be but an acre, and he have elsewhere free or copy, that maintaineth horse or other cattle of great value, the lord may seize the best for his heriot, due for that acre.

16. Whether are not the fines for admittances of a new customary tenant, being heir, or coming in by purchase, or upon surrender, at the will of the lord; or are the fines always certain.

This is an article whereat many tenants seem to stagger, being the nature of all men to favour themselves and their posterities, and to work so, as they may (if it be possible) make the fines certain, by looking back into times past, wherein they have found by old records, and by report of tenants before, that the fines have been certain, and so they may be in some places, though in few at this day. And it may be, former times did afford such favour, until land became of more value; but of late years, that course hath been broken, and fines become arbitrable: wherein I wish that lords and their ministers would use a mean of exacting.

17. How, and by what means, may a customary tenant forfeit his copyhold tenement, whether for felling of timber trees, ploughing up lea grounds, or meadows never tilled before, or for suffering his houses to decay, or for pulling down any houses, or for committing any other wilful waste, or devising his customary tenement or lands, for longer term than the custom of the manor will bear; or for committing any other act contrary to the custom of the manor. And whether hath any tenant of the manor offended in any of the former things, who is it, and wherein is any such offence committed.

Divers acts there be, whereby a tenant in one manor may forfeit his copyhold tenement, which act is no forfeiture in another manor; for customs are very different in divers manors. For in some manors a man may cut down wood and timber trees upon his copyhold land, and sell them at his pleasure, which in some manors is a forfeiture.

Some manors do allow the customary tenants of the same to let their land for three years, some for more, without the lord's license; and in some manors to let the same above a year, is a forfeiture; wherein is admitted an intolerable error in many places, namely, a tenant having let his land for a year, lets it a second, a third, etc., which is a mere deceit; for he ought to let it one year, and unless he have license, he is to take it into his hands one whole year before he let it again.

In some manors a man may let fall all his customary houses, which in some other manors is a forfeiture.

In some manors a man may not plough up, or sow, his copyhold meadow, or lea ground, that hath not been used to to be tilled; in some manors contrary.

So that these kinds of forfeitures are according to the custom of every manor, which yet tenants will endeavour to wrest.

18. What are the customs of the manor in general, both in the behalf of the lord, to perform or suffer to the benefit of his tenants, and of the tenants to perform to the service of the lord.

In the beginning of every manor, there was a mutual respect of assistance between the lord,—who gave parcels of land, whether in fee or to hold at will, or upon other conditions—and the tenants of every nature, for aiding, strengthening, and defending each other; the continuance of which first proposed course, hath bred that which is now called custom, by the favour of time. And, thereby, that which at the beginning came *ex gratiâ domini*, is now maintained by a strong hand against the lord, and what came of a voluntary consent of service of the tenant to the lord, the lord may exact of his tenants by law; and either, in right of custom due to other, constraineth each other to do that which in the beginning was of either part voluntary.

Customs are of divers kinds, and diversely to be performed. Some, in the course of inheriting of land, some in the way of women's dowries, some in the estates of land, some in matters of forfeitures, some in works, some in rents, some in fines, some of the lord's benevolence in allowing his tenants meat, drink, money, etc., in time of their works, as these customs in several manors severally are allowed.

Manors themselves may have strange commencements and continuance, as the honour of Rayleigh, in Essex, which hath a custom court kept yearly the Wednesday next after St. Michael's day; the court is kept in the night, and without light but as the sky gives, at a little hill without the town, called the King's-hill, where the steward writes only with coals and not with ink. And many men and manors of great worth hold of the same, and do suit unto this strange court, where the steward calls them with as low a voice as possibly he may; giving no notice when he goes to the hill to keep the same court, and he that attends not is deeply amerced, if the steward will.

The title and entry of the court is as followeth, viz.—

RAYLEIGH HONOR.

> Curia de domino Rege dicta, sine lege,
> Tenta est ibidem, per ejusdem consuetudinem
> Ante ortum solis luceat nisi Polus
> Seneseallus solus, scribit nisi colis.
> Clamat clam pro Rege, in curia sine lege.
> Et qui non cito venerit citius pœnitebit,
> Si venerit cum lumine errat in regimine.
> Et dum sunt sine lumine capti sunt in crimine
> Curia sine cura jurata de injuria.
> Tenta est die Mercurii prox post festum St. Michaeli

But for particular manors, as the customs of them are many and divers, so it behoveth every tenant to know whereunto he is bound by custom; if there be no ancient custom-roll to lead them, it behoveth the Surveyor to renew the same, wherein he is to set down every tenant's name, his tenements, lands, meadows, pastures, etc., the rent and service due for every of them, and whether works be turned into rent, and to indent the same, that the lord may have the one part and the tenants another. The neglect whereof hath bred many inconveniences, both to lords and tenants, by quarrels and suits.

19. Whether is there within this manor any villein or neif, namely, any bond-man or bond-woman; if there be, what are their names, what land do they hold and what is the same yearly worth, and what goods possess they.

Although this kind of tenure be in manner worn out of use, yet some there are, no doubt, though concealed in some manors, never enfranchised or manumised.

20. Whether hath any tenant or other person within this manor, stocked up any hedge-row, ploughed up any baulk or land share, removed any meer-stone, landmark, or other bound, between the lord's demesne and the tenant's freehold or customary land of inheritance, or between his freehold and customary land, or between this and another manor or lordship; where is any such offence committed, by whom, and where ought the same bound so removed, altered, taken away, or displaced, to stand. Solomon counselleth not to remove the ancient bounds which our fathers have made. (Proverbs, xxii, 28.)

This is a necessary article to be duly considered, because that by this means of removing or taking away meer-stones and landmarks, the lord oftentimes incurreth great prejudice; for, that when a lease of the lord's demesnes, being either a freeholder or a customary tenant of inheritance, hath land of his own adjoining unto the demesnes, or intermixed, and he take away the marks of division, leaveth the matter doubtful which is the lord's, especially where a long lease or patent is, whereby the tenant hath time to make alteration; and it is no new or strange thing to attach some by name or place, that are culpable and have yielded to reformation, being found out before their intents were fully ripe. And, above all, such are most worthy to be punished for altering any such known marks, under whatsoever pretence of ease or necessity, which is the common cloak of the mischief, used most in the King's lands, where long patents are granted.

21. What customary cottages there are within this lordship, tofts, crofts, or curtilages; what are the tenants' names, what rent pay they, and what services do they.

It is to be understood, *cottagium* signifieth as much as *casum*, a little house, or a place of abode only, or a little dwelling, whereunto little ground belongeth, but an orchard, garden, or some small toft, croft, or curtilage; but cottages of themselves are not ancient, as I take it: a toft is a little piece of land, upon which sometimes was situate a dwelling house, and, in Lincolnshire, a cottage is called a toft: a croft is a little piele or pightel, pingle, or small plot, near a dwelling house.

22. Whether there are within this manor any new tenements, or cottages, barns, walls, sheds, hovels, hedges, ditches, or such like, erected, set up, or made; or any watercourses or ponds digged upon any part of the lord's waste, without the lord's license, where is it, and by whom was it done, and by whose license, and upon what consideration.

The overmuch liberty of too many new erections breedeth sundry inconveniences, not only to a manor and the lord and tenants thereof, but to a whole commonwealth, and, therefore, not to be permitted without good consideration; although it is most convenient that the poor should have shelter and places to shroud them in, if they be found honest, virtuous, painful, and men of ability to gain their own and their families relief.

But it is observed in some parts where I have travelled, where great and spacious wastes, mountains, woods, forests, and heaths are, that many such cottages are set up, the people given to little or no kind of labour, living very hardly with oaten bread, sour whey, and goat's milk, dwelling far from any church or chapel, and are as ignorant of God, or of any civil course of life, as the very savages amongst the infidels, in a manner which is lamentable, and fit to be reformed by the lord of the manor.

23. What tenants there are within this manor, that do hold any lands or tenements by indenture of lease: what are their names, what land hold they, for what rent, under what conditions and covenants, for what term of years, or lives.

This article is most especially to be observed, touching the covenants by view of the tenants' leases, but the jury is to find the names, and to present them with the land and rent as far as they can learn.

24. Whether hath or doth the lord employ any land to justment, as in taking in cattle to pasture and herbage: who hath the disposing of the same, what quantity of land is so disposed, and how many cattle will it pasture; and what is a cow, ox, horse, or sheep-gate worth by the year, or by the week, within this manor.

Much land is thus used in Yorkshire, and other places northward, more beneficially than to stock it.

25. Whether hath the lord of this manor any customary water-mill, wind-mill, horse-mill, grist-mill, malt-mill, walk-mill, or fulling-mill. Whether is there within this manor any other mill, iron mill, furnace or hammer, paper-mill, sawing-mill, sheer-mill, or any other kind of mill: what is it worth by the year, and in whose occupation is it.

Where sufficient rivers, brooks, stagnes, ponds, or water-courses are, there are commonly some kinds of mills, or other profitable devices, that human wit and invention hath set up for necessary uses, for the benefit of man, and for the lord's profit of the manor, where such devices are erected. And yet all kinds of devices are not convenient in all places: as where no lead, tin, or coal is, there is no need of the use of water, to move a wheel, to blow the fire for the melting and trying thereof; yet there may be like use for iron ore, and where neither of them is, there may be use of walk-mills, or fulling-mills: and where those are not, yet there may be use of corn-mills, and such like. And in some places the force of water-courses is used to raise water out of one place into another, where the natural current denieth the coming, and mounting thereof; with infinite other devices, according to the situation of the place, and necessity of the thing required. Which, though they be not all mills to grind corn, yet may they bring profit to the lord, which is the thing the Surveyor should covet, not only to observe what is already, but must have also some judgment to erect some, if the water-course will conveniently afford the same to increase the lord's revenues.

To the corn-mill, which are custom mills, doth belong a kind of duty from the tenants, that is, that they are bound to grind their corn at the lord's mill: and that kind of custom is called socome.

Bailiff. Must a customary tenant of a manor, where such a mill is, be forced to grind all the corn he spendeth in his house, at the lord's mill?

Surv. Of necessity, if it grow upon the manor; or else the lord may amerce him for his fault.

Bailiff. What if he be forced to buy it in the market?

Surv. Surely then it is a question, whether he be bound to grind it there or not. But I take it, he is at liberty to grind it where he will, even where he finds himself best served. For there is bond-socome, that is, where the tenant is bound by custom; and love-socome where he grindeth of free-will.

Bailiff. We that are tenants would be glad if you could tell us, what toll our miller may take; for we are much abused in it, as we think; and because we be bound by custom, we cannot conveniently leave the mill, yet we find no remedy of the miller's abuses.

Surv. As touching toll (which word cometh of the verb *tollo*, to take away, as it seemeth), there are so many differences, by grants made by lords of manors, that the certainty in general can hardly be declared. Some millers take a twentieth, some four-and-twentieth part; tenants at will should pay a sixteenth part, and a bond-tenant a twelfth part, and some are toll-free. But howsoever the toll be, fear not, the miller will be no loser: and for his abuses, you have your remedy in the lord's court, or at the common law.

26. Whether hath the lord of the manor any peculiar fishing within any river, brook, mere, stagne, pond, or other water: where and how far doth it extend, and what it is yearly worth, and who be farmers thereunto, and what common fishings are therein, and how is the same used.

As this article is little needful to be propounded in manors where no rivers of sufficient waters are for fishing: so it is very necessary to be examined, where such waters are. For it is daily observed, that many abuses are committed against the lord himself, by such as usurp his peculiar fishing, and against the commonwealth, in destroying fish, as appeareth by the punishment ordained against offenders therein, (25 *Hen.* 8, *c.* 7, and 31 *Hen.* 8, *c.* 2). Therefore it behoveth the Surveyor to be more careful in seeking the means how to raise a profit unto the lord by his fishing, than to find the present abuses which are inquirable, and punishable at every leet, although, if any apparent offenders be found, he is to advertise the lord for reformation; but not inroll the same in his book of survey. For nothing is therein to be inserted, but matter of perpetuity, in recommending the present state of the manor unto posterities, and for the lord's immediate use: the court rolls of the manor do shew the abuses and punishments in those kinds. And therefore, besides the ordinary fishing in small land rivers, brooks, and ponds, there must be also remembered what profit may arise by fishing in the sea, if the manor be near it, or any creek thereof, in oysters, muscles, cockles, crabs, crayfishes, and such like.

27. Whether hath the lord of the manor any fowling within this manor, by means of any moors, marshes, waters, brooks, reeds, or such like: as of duck, mallard, widgeon, teal, wild-goose, bustard, plover, bittern, swan, or such like fowl; or any woods wherein do breed any herons, shovellers, storks, or such like; or any pebble, beach, or sea-bank, wherein breed sea-pies, olives, pewits, or such; who taketh the profit of them, and what are they, or may they be worth by the year, unto the lord.

These kinds of commodities are not in every manor; and, therefore, as in all other things, it behoveth the Surveyor to consider of these particulars, and give no more unto the jury to be inquired of, then he either knoweth to be inquirable, or likely by examination to be found in the manor he intendeth to survey, yet not to omit any whereby the lord's revenues may be increased, nor to trouble the jury with needless articles.

28. Whether hath not the lord of this manor (time out of mind) had and received all waifs, estrays, felon's goods, treasure found, within the manor, and such like profits, and whether hath he been answered of them from time to time truly, or not, and who is the officer that oversees and takes notice of the same to the lord's use, and whether they be totally and fully answered.

Although these kinds of profits may redound unto the lord by prescription, yet most commonly they are confirmed by charter, and therefore the lord's evidences, together with the use, must be examined, as also how and by whom these casualties are priced, wherein lords are often abused.

29. Whether there are within this manor, any tin-mines, lead-mines, copper-mines, coal-mines, quarries of stone, of marble, free-stones, mill-stones, lime-stones, grinding-stones, marl, or chalk-pits, slimy or moorish earth, fit for soiling of land, or any potters' clay, clay for brick or tile, or any fuller's earth, or any sand, or gravel-pits, or such kind of commodities, and what is every such kind worth to the lord, or may be worth by year.

These are casualties, and seldom or never happen in any manor together; and few manors but have some or one of them, which may be very beneficial to the lord, if the Surveyor be willing and skilful to advantage the lord.

30. Whether hath the lord of the manor any bushes, turfs, peats, heath, broom, furze, fern, or flag, which are, or may be, yearly sold within the manor, and what may they yield the lord by year, if they were improved to the uttermost value.

These things are not in every country, much less in every manor, for I think Essex can afford little of them, unless it be of turfs and peats, if they were sought in some low grounds in some creek of the sea. Northumberland, Westmoreland, and those wild fells, yield store of peats and turfs: so doth Lincolnshire, Cambridgeshire, Yorkshire, Lancashire, and other places, many within this kingdom, which would be very profitable, make good fuel, and save much wood.

Bailiff. What mean you by turfs and peats?—are they not heath turfs you mean?

Surv. There are heath turfs, which are also meant in this article, but the turf and peat is of another kind: for they are taken in bogs, and such rotten grounds as cattle cannot feed upon. And those that are first cut up, are called turfs of the upper part, and such as are taken downward, are called peats.

Bailiff. How mean you downward?

Surv. Under the first cut; for you may cut a spear's length deep in some places in the summer time, and that kind of earth will burn very excellently. And if it be cut never so deep, it will fill again in a few years, and then may it be digged again; insomuch that the profit will be continual to the lord, and the use to the country.

Bailiff. Then it is beneficial ground.

Surv. So it is; and I think there be many grounds would serve to this purpose, if they were sought out, where scarcity of other fuel is. But there is no greater enemy to thrift than idleness, and ignorance of things of use not in use. For in many places, such is the scarcity of wood and furze, as they are enforced to burn cow-dung.

Bailiff. That is a strange fuel; as for furze, I take that to be no good fuel, but to brew or bake withal, it maketh only a flame as doth stubble or straw.

Surv. Yes; it is good fire-wood in Devonshire and Cornwall, where they make great profit in vending it for that use, in many of the greatest towns, and in Exeter especially.

Bailiff. Then are they better than our ordinary furze about us?

Surv. The country people do call them French furze; they have a very great stalk, and grow very high, and their prickle very strong; but that they grow thick, and the body is commonly bare to the top, where is only a green bush of the tender and small branches, and seldom elsewhere, so that they easily make them into faggots, and so vend them with great profit.

31. Whether is there within the manor any slate-stones for tiling, red or black lead, or ochre for marking-stones.

These kind of slate-stones are full in Cornwall, and the marking-stones most about Derbyshire, and those parts northward, as are also mill-stones about the Peak.

32. What deer hath the lord of this manor in his park, red or fallow; how many of antler, and how many rascal; who is keeper, and what is his fee by year; whether hath he any warren of conies or hare; who is the keeper of either of them, and what fee hath he by year, and what is the warren of conies worth by year, and what were the park worth by acre to be let by year, if the deer were destroyed, and how many acres are there within the pale.

A park for deer is more for the pleasure, than for the profit of the lord or commonwealth, and yet fit that princes and men of worth should maintain them at their pleasures,—yet not so fit, that every man that listed should maintain that game, for his private pleasure, that depriveth a commonwealth of more

necessary commodities. But men of late are grown more considerate, and have dis-parked much of this kind of ground, and converted it to better uses. As for warrens of conies, they are not unnecessary, and they require no rich ground to feed in, but mean pasture and craggy grounds are fittest for them. It is therefore in the discretion of a good and circumspect Surveyor, to advise his lord how to dispose of these things for his best advantage. And in craggy and unprofitable grounds to keep goats, especially where they may not annoy profitable things.

33. What pensions, portions, payments, or fees, are, or ought to be, yearly paid out of this manor; to whom are they paid, and for what; and what rent or annuity is there paid, or ought yearly to be paid, out of any manor, or by any person, unto the lord of this manor; and whether hath the same been duly paid, or discontinued; what is the annuity or rent; by whom ought it to be paid, for what thing, and how long hath it been discontinued.

These things are very duly to be examined, both which go out of a manor, or be paid to a manor, although, in many places, they be much neglected,—not in calling for, I confess; but if such payments be denied, the lord, to whom such things are due, can hardly say or avow for what, or in consideration whereof, they are due. And by that means men lose their right, both of the payment, and sometimes of the land, if it be escheat; yea, whole manors sometimes.

34. Whether is there within this manor any market, weekly, or fair, at any time of the year kept; on what day or days; who hath the toll and profits of the same; and what is it, or may it be, worth unto the lord by year; whether in his own hands, or let to farm, and for what rent.

Fairs and markets are commonly by patent from the King, and consequently the toll standings and stallages.

35. Whether doth the lord, or may he, take in any swine to pannage yearly into his park or woods, what is the pannage worth by year.

Bailiff. Sir, you need little to inquire of that; for oaks and beech, that have been formerly very famous in many parts of this kingdom, for feeding the farmers' venison, are fallen to the ground and gone, and their places are scarcely known where they stood. "*Jam seges est ubi quercus erat.*"

Surv. It is very true; and it is pity that lords of the manors have no more care of their posterities. For assuredly there will be greater want of timber, in time to come, in this realm, than may be supplied, with little charge, from any part else whatsoever. And therefore might lords and farmers easily add some supply, of future hope, in setting, for every twenty acres of other land, one acre of acorns, which would come to be good timber in his son's age; especially where there is, and like to be, more want.

Bailiff. The course were good; but you prefix too short a time far, for oaks are slow of growth, and it will be long ere they come to be timber.

Surv. I know, in Suffolk, where, in twenty years, acorns have yielded fruit already, nearly as high as a steeple of ordinary height.

Bailiff. Truly it is pity it were not enjoined to men of ability and land to do it. But I think men imagine there will be timber enough to the end of the world, as many things else presage it cannot stand long.

36. Whether hath not the lord leet and law day within the manor, which is the extent of the precinct; and whether is there not a court kept within the manor from three weeks to three weeks, and what sum or value hath the court power to determine.

Bailiff. If leets and views of frank-pledge were duly kept, and the true meaning of the first creation of them, and their powers duly executed, they would reform many abuses in the commonwealth.

Surv. It is true; but the negligence of lords, and corruption of stewards, have much impeached both the credit and use of those most necessary courts.

37. Whether hath any of you any deeds, evidences, court-rolls, rentals, suit-rolls, custom-rolls, books of survey, accounts, or any other escripts, or muniments, touching or concerning this manor. If you have any such, produce them at this court, for the lord's use and service; or if you know any that have any such, deliver their names, that the lord may procure them, to show the same.

Men that have such are nice in delivering them; but if they have them, and conceal them, they are no good tenants in not revealing them; and, without records, there can hardly be a good survey.

38. Who hath the advowson, nomination, presentation, and gift of the parsonage, vicarage, or free-chapel, whereunto this manor belongeth; or whether is it an impropriation belonging to the lord of this manor; who is incumbent of the parsonage or vicarage, or who hath the impropriation in use, and what is it worth by year.

Some have taken and set down a parsonage or vicarage to be parcel of a manor; but I take it otherwise, for a matter of spiritual or ecclesiastical function cannot be parcel of a secular living. But a manor, as touching the tithe, may belong to an ecclesiastical charge; neither do I think that an impropriation, though it belong unto the lord, yet is it not parcel of his manor; because that, *ab origine*, even from the first institution, it was dedicated to a spiritual office. And although the profits were afterwards disposed to a secular person, yet are not the profits parcel of the manor.

39. Whether is there any land concealed, or rent detained, within this manor; and by whom, for what, how much, how long; or whether is any land granted in mortmain.

40. Who is the lord's bailiff, what is his name, what yearly fee hath he, and whether hath he a patent for life, or is at the lord's will; and who is steward of the lord's courts, what is his fee, and whether doth he hold it by patent, or at will; who is woodward; and what other officers are there within, or belonging to, this manor, and what are their fees.

Sundry manors have sundry officers: some of the lords' election and appointment, and some of the tenants', among whom there are yearly chosen, as Hayward, Reeves, etc.

41. Within what diocese and deanery, within what division and hundred lieth this manor, and to what place are you that are the tenants usually called to do your services, to muster, and to shew your armour and weapons; and what beacons are you appointed to watch and ward at.

It were a simple part of a Surveyor, if his lord should ask him these questions, and he should answer, I cannot tell; and yet are they things fit for the lord to be acquainted with upon sundry occasions.

42. What market towns are nearest unto this manor, and what commodities are there especially vented at every of them.

This is also necessary to be known of the lord that dwelleth remote from his manors, for many reasons. Thus much for the charge.

Every Surveyor is in discretion to order his own business, and none is tied to this method of charge; yet he must take the substance of these articles, or such and so many of them, as in his conceit (guided by some foreknowledge of the state of the manor which he is to survey) are fittest to be delivered unto the jury; and, withall, he is to explain unto them the sense and meaning of every article more at large than he will give them in the letter. And, having thus finished the charge, I hold it fit to give the articles in writing unto the jury, to the end they may answer their knowledges to every of them in writing. And because the jury, perchance, cannot so methodically set down their own plain meanings as is fit to be engrossed in the lord's book, the Surveyor must correct the same, still keeping himself within the compass of the meaning of the jury, and then to read

the same unto them distinctly, that they may allow or disallow the same; and because they shall have sufficient time to consult and deliberate upon every article, they may have day given them, until such time as the Surveyor doth think he shall finish the perambulation and view of the manor in such sort as he intendeth, and then to take their verdict, and accordingly to engross the same, together with his own private necessary observations touching the same.

Immediately after the charge thus ended, the Surveyor is to make proclamation in the name of the lord of the manor, that every tenant do presently produce his deeds, copies, leases, and other evidences, to the end that the Surveyor, and his clerk, may enter them roughly in a book; and afterward enrol them fair in a book of parchment for continuance.

And if any man make default, he may find it by the catalogue of the names of the tenants, which he must take at the beginning of the court, and cross them as they bring their evidences to be entered; the manner of which entries doth briefly follow:—

BEAULAND MANERIUM.

Intrationes omnium et singularium Chartarum, copiarum, indenturarum, omniumque aliarum Evident. tenentium, ibidem factæ tertio die Novemb. anno Regni Domini nostri Jacobi, Dei gratia, Magnæ Britanniæ, Franciæ et Hiberniæ Regis, fidei defensoris, etc. 4. *ut sequuntur, viz.*

CHARTÆ LIBERORUM TENENTIUM.

W. P. de F. Com. M. yeoman, per chartam dat. tertio die Martii, anno regni Hen. 7. secundo, tenet libere sibi et hæredibus suis (if it be entailed, then according to the limitation) ex donat. R.S. unum mesuagium sive tentm. vocat. Whytlocks, situat. in quadam venella vocat. Potters-street, inter mesuag. R. L. ex austr. et quandam viam vocat. Love-lane ex parte Bor. abutton. super magnam communiam vocat. Hownes-moore in Occiden. et super com. campum vocat. Beggars Bushfield in Orientem, et continet in longitudine quadragint. pertic. et in latitudine novem pertic. et dimid. unum clm. prati. vocat. Mosse-meadow, cont. per estimat. quinque acr. et quinque acr. prat. jac. in commun. prat. vocat. Colliers-mead, et tres clausur. terræ arabilis insimul jacent. vocat. Bathyes, cont. in se in to. per estimat. decem acr. unum clm. pastur. vocat. Abbots-close, jacent. etc. cont. per estimat. tres acr. Quod quidem mesuagium præd. R. S. nuper perquisivit, de quodam A.B. habend. etc. per redd. unius libr. Piperis, et per servic. inde debit. et consuet. — I. Libr. Piperis.

In hac forma cæteræ omnes irrotulentur chartæ, secundum particularia in eisdem specificata.

COPIARUM CUSTUMARIORUM TENENTIUM, INTRATIO.

Finis. £3. 6s. 8d. — *B. C. per cop. Cur. dat. nono die Maii an. regni Elizab. 30. tenet exsursum redditione. W. R. unum tentm. jacent. in quodam vico vocat. Church-street, int. etc. (according to the buttals) et unam clm. terræ voc. Heywood jac. etc. cont. per estimat. duas acr. unum pratum vocat. Deare-meade, cont. quinque acr. et decem. acr. terr. in com. campis. Habendum sibi et hæred. suis ad voluntatem domini secundum consuetudinem manerii, et dedit domino pro fine £3. 6s. 8d. et reddit per annum.* — 2s. 6d.

If the estates be for lives, as in the most manors in the west, then the entries of the copies must be according to the words of the copy; and at the foot of the entry of every copy, it is fit to set down the ages of the tenant in possession, and of them in reversion.

Also it behoveth a Surveyor, in the entry of all deeds and copies, to set down the names of all messuages and tenements, and the names of every particular close and parcel of land as they are set down in the copy. And not only the present tenants, but two, three, or four descents, if it be expressed in the copies.

It is a fault in some stewards, that, in making out copies, do set only down the name of him that surrenders, and the name of him to whom the surrender is made, without further relation of any former tenant's name; and do also set down the messuage, without setting down the particular parcels of land belonging unto it, the rent or fine, using only general words, which in all things import uncertainty. Whereas, if he did well, he should observe and set down every parcel both in quality and quantity; namely, what is meadow, pasture, arable, wood, etc., with the principal butts and bounds, by the Surveyor's book. But for want of true surveys many beneficial things are omitted, and many hurtful admitted.

DE INTRATIONE DIMISSIONUM, SIVE INDENTURARUM IN QUIBUS EA QUÆ SEQUUNTUR OBSERVANDA SUNT PRÆCIPUE.

Dies, mensis, et annus.
Partes, inter quas facta est indentura.
Consideratio concessionis.
Particularia quæ per indenturam traduntur.
Habendum, cum termino annorum aut vitarum, pro quo aut quibus conceduntur.
Redditus, et tempora solutionis.
Clausa districtionis, aut foris facturæ.
Conventiones, et provisiones breviter, sed distincte.
Quomodo obligatur ad warrantizandum concessor, etc.

This sufficeth for the form of the entry of deeds, copies, and leases.

Bailiff. Is this all that is required in the making up of a book of survey?

Surv. Some think it sufficient to come into a manor and to call the tenants, and to cause them to shew their evidences, and to enter them, and so to give the lord a book of the estates, and think they have done a great work; which is as much as if a caterer should provide meat, and the cook to send it to the table raw for his lord to eat. The caterer's office doth as much towards the lord's diet, as the bare knowledge of the estates of a manor doth towards the performing of an absolute survey. Yet is the caterer's office a good inducement, and without his provision the cook can do nothing.; and without the knowledge of the estates a Surveyor's travail is to little purpose.

Bailiff. Yet you will enter every man's particular lands again, will you not, notwithstanding the entering of their evidences?

Surv. It must be so, after the view had and made of all the manor.

Bailiff. What else require you at my hands to be done then at this time? for I perceive you have given the jury their charge, and limited them a day to bring in their verdict: and you have seen and entered all the deeds, copies, and leases of the tenants which have appeared. What will you now do in the mean time?

Surv. I must now command you (the lord's bailiff) to appoint me some sufficient tenants to accompany me in the perambulation and description of the manor.

Bailiff. What, will you make a plot of the manor?

Surv. Yes; for it is very expedient and necessary for many causes, which I shewed you in our first conference.

Bailiff. I pray you let us proceed in our intended business; we have company sufficient both for your instruction of every man's land, and to aid you to carry the chain; as for your instrument, I will carry it. Is it much material where you begin?

Surv. Truly no; yet I hold it most fit to begin about the middle of the manor; and then to take a course, as the convenient lying of the land will move us, or at one end or side, all is one.

Bailiff. Then I think here is a convenient place to begin the business; here is a spacious waste, and near about the middle of the manor.

Surv. What call you this common?

Bailiff. Ye that are tenants, and are sworn, inform the Surveyor.

Jury. Sir, it is called Water-hurst-common.

Surv. What field call you this?

Jury. Ox-lease.

Surv. Whose is it?

Jury. Thomas Turner's.

Surv. How doth he hold it?

Jury. He holds it by copy of court-roll.

Surv. It is meadow?

Jury. Yea; as we call it, Upland-meadows.

Bailiff. I perceive you write the names of the commons and closes you take, and the name of the owners and occupiers, and the quality of the ground, and how it is held in every particular close.

Surv. I must of necessity do so; for memory may not be trusted to retain so many things, as are to be noted in this business.

Bailiff. I pray you proceed to the rest.

Surv. What river call you this?

Bailiff. Will you have the names of the rivers too?

Surv. Yea, and the name of every other particular else whatsoever; for it is very material whether it be river, brook, lane, highway, cross, tree, pond, hill, hedge, corner, gate, style, gravel, or sand-pit, meer-stones, baulkes, land-shares, or any matter or thing memorable, because they are often mentioned in records, butts, boundaries, deeds, copies, leases, and to distingush between land and land, manor and manor, parish and parish, and such like.

Bailiff. Indeed, I perceive it is very material to remember them all; this river is called Otter-brook, and is indeed the bounds between this manor of Beauland and the next manor.

Surv. What call you the next manor, on the other side the river?

Bailiff. The manor of Littleton. But will you observe the names of all the manors that border upon this manor?

Surv. Yea, of necessity, and whose manor it is; for it were a simple part in me to take the circuit of this manor, and if the lord should ask me what manors lay about it, I should answer I cannot tell. It is fit the lord should know who are his neighbour lords, and what manors were near him. Whose is the manor of Littleton?

Bailiff. The King's manor; and, therefore, whether you may boldly set it down, you may be advised.

Surv. There is no fear where is no purpose of offence, and in this, it is not only not offensive, but expedient that the true bounds, meers, and marks of division between manor and manors should be observed and set down, that either may know how far his own extendeth. But what house is this?

Bailiff. These men of the jury will tell you better than I; for I am but a stranger here to speak of, and I dare not be too bold to speak either by guess or by report, of things which must be recorded to posterities.

Surv. You do better to forbear, and to be silent indeed, than to speak what may lead us into error, as many busy and forward fellows do, to the hurt sometimes to the lord, sometimes of the tenant. And some Surveyor, over-credulous, will take their raw reports for matter of record, and so leave doubts or untruths to them that shall come after. But what say you that have been sworn?

Jury. The name of the house is Fullers; but why it is so called, we cannot tell.

Surv. It is so called (no doubt) of some former tenant of that name; for houses and farms are oftentimes called of sundry names, according to the variety of the tenants' names; and it is a good course to set down all the ancient names of a farm, because in ancient records names are found both of farms and closes, and such like, that are out of knowledge, for want of the continuance of expressing them in their copies, deeds, leases, rentals, suit rolls, and custom rolls. But whose is the house now?

Jury. It is now in the tenure of William Sands.

Surv. How doth he hold it?

Jury. By lease, for twenty-one years.

Surv. When I come to any of the land that belongeth to this house, let me understand it; for it is convenient to mention, in setting down every piece of ground, to what house, farm, or tenement, it belongeth.

Bailiff. Here you are now come to the lord's wood.

Surv. What call you this wood?

Bailiff. I take it, it is called Frith-wood.

Surv. It is parcel of the lord's demesnes, is it not?

Jury. It is so, sir.

Surv. Here are good timber trees, we will number them.

Bailiff. Number them? how is it possible to number them; they are so many, and stand so thick?

Surv. I confess (especially if it be thick of bushes and underwood), there is difficulty in numbering them.

Bailiff. To what end is it; what is the lord the better, to know the number of the trees?

Surv. Howsoever the lord be pleased to think of the service, a Surveyor ought to know it; that when he shall be demanded of the lord, what he thinketh the wood to be worth if to be sold, he may be able to answer it, and give a reason for that he saith; and not to speak at random, or by guess, without some ground of reason or proof. For how can a man value a wood, when he knows not what crop it beareth? For a wood may have an hundred trees in an acre; some woods not twenty; some not five; and, therefore, it were great negligence in a Surveyor that would pass by a wood of the lord's and would not take note of the trees, yea, and of the reasonable value of them one with another, that he may readily be able to satisfy the lord when he shall demand the Surveyor's opinion, though he cannot answer precisely, yet near.

Bailiff. You say truly; but what if there be no trees at all in the wood; as here is a wood adjoining, called Buck's-grove, that hath the name of a wood, but hath no trees at all?

Surv. Then is it underwood which must be considered in another kind, for there is difference between timber trees and underwoods; for an acre of timber trees may be worth forty pounds, and far more, or much less; when an acre of underwoods cannot lightly exceed five pounds, and may not be worth twenty shillings. Therefore, must a Surveyor be heedful, I say, to note what trees are among the underwoods, and must also have skill to judge of the values of the trees,—namely, to judge what a ton of timber, or a load, is worth, and how many loads a tree will make. And because this is not alike in all places, he must be careful to observe the plenty or scarcity, the use and little use of timber or fire-wood, in the place where he is to deal, and, accordingly, in discretion to judge of the values of that he hath in hand, else may he deceive himself and his lord much, if he prize wood in the weald of Sussex as it is worth about Salisbury Plain.

Bailiff. Saving your speech, the like is to be considered in the letting and sale of land.

Surv. Some there is; more in opinion than in deed; for the difference of prices of land of like quality cannot be so great in several places; for land that will yield per acre, like feeding in pasture, burden of hay, or profit in tilling, will yield like maintenance of families of equal companies; and, therefore, in reason, the difference of yearly values of land of like quality differ not much.

Bailiff. In reason, indeed, the difference should not be great, yet is commonly valued according to the vent of commodities: but let this pass.

Surv. We have had a good walk between these two stations, and a long discourse. But, methinks, I see a quarry of very good stone here.

Bailiff. Yea, sir, here is both excellent free-stone and good marble; and as we shall go, you shall find divers sorts of minerals and earths; which you cannot note upon your plot, because they are things hidden under the earth.

Surv. Yea, but I will (for so I ought) set down in the plot the place where every of these commodities are found. But for the matter and substance, and the profit and value, I know the jury will bring in their verdict, for they are all given them in

charge, and as I shall find in mine own opinion, I will likewise compare with the jury's, and so set it down for the lord's instruction.

Bailiff. These things are necessarily given in charge. But here is a mill, sir; will you take note of it upon your plot?

Surv. In any case; for it is not the least ornament of a manor, a fair stream, and a well-conditioned and well-wrought mill, upon the same. In whose use or occupation is this mill?

Bailiff. It is one G. Johnson's.

Surv. By what right?

Bailiff. Let them of the jury speak.

Jury. He holdeth it freely for a pepper-corn a-year. But it was parcel of the lord's demesnes, but he sold it; and it was a custom mill, very profitable.

Surv. He that persuaded the lord to sell away his custom mill, had little respect to the lord's profit or royalty; the profit comes easily, and the custom confirmeth the antiquity of the manor: and such a member of a manor I would wish none to put away. But humour and necessity are two opposite emperors: the one commands, willeth, and doth what he listeth; the other is forced to do what it would not. And, therefore, men that may do what they list, and will do what they may, if they err to their own hurt, are not to be lamented. But they that are constrained to do what they would not to their prejudice, I pity them. But, I take it, we have near trodden the whole manor.

Bailiff. Almost, indeed. Here are some few closes more, and then an end.

Surv. But here are certain cottages, methinks, builded upon the lord's waste.

Bailiff. Yea; but let them pass, never meddle with them; for they are only shelter for poor people, and yield the lord little or no commodity; and therefore spare labour of observing them.

Surv. Nay; it is a parcel of my task; I must omit nothing that may inform or benefit the lord.

Bailiff. Be it then as you will.

Surv. What, are we now at an end?

Bailiff. Yonder corner is the last; for it is the place where you began, in Water-hurst Common.

Surv. So: then we will retire.

Bailiff. What will you then command to be done?

Surv. Cause the tenants all to appear, and let the jury bring in their verdict.

Bailiff. The tenants are at the Court-house, and the jury ready with their presentment.

Surv. I will go with you and take it. Make proclamation, and call the jury by poll.

Bailiff. They all appear.

Surv. You, sworn-men of the court of survey, have you agreed upon the answer of the articles that were given you in charge; and are you provided with answer unto every of them in writing?

Jury. Yes, sir; here it is, fairly written.

Surv. You have well done in your endeavours, though, peradventure, there may be defects in the form of your answers; yet, if you have observed the main purpose, which is the seeking out and the delivering the truth, you have discharged the parts of honest tenants, and men fearing God. And because that it may be, some things may be omitted, which you may not instantly call to mind, blush not to declare it here, before you be deprived of that you have written; for this paper I must have, and that under your hands.

Jury. What need we set to our hands?

Surv. Because, if I err from it, your hands shall testify against me; if you have erred, and I err through you, your hands shall justify me.

Jury. The thing is reasonable; we will subscribe.

Surv. Now will I read the articles of your charge, and, to every article, your answer, that you may yet correct or add what shall be thought fit; and therefore, I pray you, listen.

Jury. Read you, sir.

Surv. You agree to all these things willingly, whereunto you have set your hands.

Jury. We do so, and do here confirm it by the delivery thereof, by our foreman, in the name of us all, to the behoof of our lord. And what you else require at our hands, we are ready to perform.

Surv. You do kindly, and like dutiful tenants; and be you assured that your forwardness herein shall not be concealed from the lord; but with true report of your endeavours for the furthering of the business, which cannot but draw a kind consideration from the lord again to you: which, both to gain for you, and to retain it, I will truly do my best. And so, for this time, I will leave to trouble you further, until I have set my other collections, which I have taken in the perambulation of the manor, in some order; then will I be bold to trouble you again, to the end that you may all approve what is done, whether I have truly set down the particulars: namely, the lord's demesnes, the free, copy, and leased lands, under their true names and due owners; if not, that, by your help, I may reform it before I engross it to continue to your children. For what we do, will be hereafter a light unto them that shall come after you; and if it should be erroneous, it would be prejudicial to your posterities.

Jury. I pray you, therefore, let there be an examination; and we will gladly give both our attendance, and best aid, to perfect it.

Bailiff. I shall then make an "*O yes,*" and adjourn the court until they have notice again.

Surv. Do so.

Bailiff. You will now keep your chamber until you have made your collections perfect, and cast up the land.

Surv. I purpose so.

Bailiff. I would gladly see the manner of your casting up of the acres, as you do it; for the rest, I shall see when you have done. For the jury's examination, I will leave you till the morning, and then will I come to your chamber.

Surv. Do so.

THE END OF THE THIRD BOOK.

[Towards the end of the second book, several passages concerning wardship, advowsons, and villanage; as also in the third book, several concerning the instruments and manner of surveying, are omitted, the last edition having been followed.]

THE FOURTH BOOK.
THE DIALOGUE BETWEEN A BAILIFF AND A SURVEYOR.

THE FIFTH BOOK.
THE DIALOGUE BETWEEN A BAILIFF AND A SURVEYOR.

[These two books, as will be seen in the table of contents, are not of sufficient interest to be inserted.]

THE SIXTH BOOK.

THE DIALOGUE BETWEEN A PURCHASER OF LAND AND A SURVEYOR.

Purchaser.

SIR, as I take it, you did survey a manor wherein I dwell, called the manor of Beauland?

Surveyor. I did survey a manor of that name, indeed.

Purch. It may be you have forgotten me, yet I was one of your jury of survey there, and I did accompany you in your perambulation of the manor; and I remember the bailiff, among many other questions, demanded you one, wherein I would have been glad to have had your opinion, but that you had no fit opportunity, at that time, to give such satisfaction as I did wish.

Surv. What, I pray you, was the question?

Purch. Whether it were better for a man that had money in his purse, a thousand marks or a thousand pounds, and could lay it out upon land, to purchase a fee-simple or to buy a lease?

Surv. I can hardly admit leisure to answer you, by reason of other occasions; but, in regard of former acquaintance, to do you a pleasure, I will borrow so much time as may afford consideration to answer this question; so you can be satisfied with some brief reasons, although I know that such are the different opinions of men in this point, as that which will fully satisfy one, will draw some others into doubt, as we see in divers other like cases:—*Multa capita, multæ sententiæ.*

Purch. I confess my judgment is mean in this point, because I have not had hitherto any practice in the purchase of land, and I must also confess that I am not provided for that business as some great masters, who can undergo matters of many thousands; yet I think it in my discretion, as fit to be well advised in the smallest as in matters of greatest moment; for a little, well employed, may prove so far more beneficial than a greater portion, by how much the same is laid out with more discretion and better judgment. And though, to tell you truly, my stock will not exceed a thousand marks, yet would I gladly bestow it upon such a thing as I might live thereby, and my children after me.

Surv. Then I perceive you would deal with some matter of perpetuity?

Purch. I mean some fee-simple; for, you know, it is a good matter to be a freeholder: it is a quietness to a man's mind to dwell upon his own, and to know his heir certain. And, indeed, I see that men are best reputed of, that are seized of matter of inheritance. Leases are but of base account; for they have oftentimes their livings taken over their heads. So has the freeholder of inheritance never. And many other fair preferments are laid upon a man that holdeth to him and his heirs, that never are bestowed upon men of inferior tenures and terms.

Surv. Are you a scholar?

Purch. No, truly.

Surv. Then Nature has taught you the art of ambition. And I fear you have set too fair a colour upon so mean a proportion, as is between your portion of money you have to bestow, and the exceeding contentments which you expect to grow by the land you purpose to purchase with the same.

Purch. Is every man that desires to purchase, ambitious?

Surv. Not as he is a purchaser. But the humour of his aspiring being discovered, discovereth his ambition to be the motive to the purchase. Will, and ableness to purchase, are in themselves so far from ambition, as it is a blessed benefit given of God to man; and a great cause of rejoicing is it, to the heart of the most religious man, when from a low estate and small portion, God doth give means to raise himself, by lawful purchase; but if all his aim therein, be a vain-glorious thirst, I cannot give it any other fitter title than ambition, which is a vice, and, methinks, I smell it in yourself, by all your former arguments of the happiness of a freeholder. It is a good thing, you say, (and so do I,) to be a freeholder. But you must think he is not so free but he is subject to many services, whereunto some inferior tenures are not, as, when you are a freeholder, experience will teach you. Also it is (as you say) a good thing to dwell upon a man's own. Freeholders only dwell not on their own: he that hath a lease but for a year, dwells upon his own for a time. As for your heir certain and apparent; no doubt it is a comfort, so it be a comfort: for comforts prove in those casual and changeable inclinations sometimes crosses. Tender heirs are like young twigs: they will bend and be wreathed at the will of the parent; but, grown strong, they prove often strong distractions to best-minded and wealthiest parents, especially when they have learned to say, My father cannot put away his land from me. Then he begins to feel his father's health to be his sickness, his father's long life his lingering death. I need not tell you what succeeds; if you see it not, the mist of partial observation dazzles your eyes; yet would I have you to know this, that I hold it great happiness for a man of that estate to have a heir, but greater, and the greatest, to have a virtuous, a frugal, and thrifty heir. Touching the reputation which you pretend to gain by the title of a freeholder of inheritance, that is seen to be won and lost as is or shall be the reports of your good or ill conversation among your neighbours, which often poor men get and rich men lose. The clearing of the fear of having your living to be taken over your head, is some reason indeed; but many times the heir, to avoid the danger, sells it himself; sometimes before it come to his hand. For the preferments commonly laid, or expected to be laid, upon a man of that estate: howsoever ambitious men may think it glorious, men wise enough, of a temperate and moderate spirit, rather embrace their own freedom, and think it far more precious than the fairest imposed or assured preferments to office, commonly accompanied with care and controlment.

Purch. I perceive you favour not estates of inheritance, the best and most absolutely reputed tenure that any man can be endowed with.

Surv. You much mistake me and the matter; for I ground not my objections upon any unworthiness of that most worthy tenure, but upon your ambitions, assuming reputation, security, office, and vain-glorious preferments, by reason of so small a mite of means as your stock (being but one thousand marks) is able to purchase.

Purch. I will purchase (as I take it) about forty pounds a year, with my thousand marks.

Surv. Thereabouts, at sixteen years' purchase; a weak revenue to support so weighty contentments as you have propounded to yourself.

Purch. I must cut my coat according to my cloth —spend no more than will arise of the farm.

Surv. But your thousand marks being gone, where is then the mean to stock your farm? for a farm without stock, is like a piece without powder, or a steeple without bells.

Purch. Truly, I confess it; but if I should reserve any of that portion for the stock, it would purchase far less: and therefore I conceive it better to strain myself some other way to stock it, though I give interest for a while, or let it out for some few years, to enable me to stock it myself afterwards.

Surv. So shall you soon indeed make trial of your adventure, either to arrive safe, with little advantage, or to suffer utter shipwreck, to lose both yourself and your ship. For the first, interest, the mother of misery, the longer she goes with her birth, the greater monster she breeds, that immediately devours him that begat it, worse than the viper that kills the mother. Of two evils, the least is, to let it. If, then, thou be accompanied with a charge, thou and thy charge must be maintained. If that eat

up thy income, or the better part of it, little will be laid up for the future stock, and so shalt thou rest *in statu quo prius*, as able in the end, as at the beginning of the term.

Purch. I know no other course to dispose of my money, in way of purchase; for lives are casual, and years run out so swiftly, as I cannot think of a better employment of my money, than to lay it out upon land of inheritance, for that is perpetual.

Surv. There are many of your mind who, by the greatness of their spirits, undermine their own estates, and so hurl voluntary repentance upon their own heads, which they cannot avoid.

Purch. If a man have a competent bargain, there needs no repentance.

Surv. A convenient bargain requires more than a competent *quid* for a competent *quo*, that is, a bargain barely worth a man's money. As he, that has a thousand pounds in his purse, and bestows it upon a jewel worth a thousand pounds; unless he purpose and can dispose this jewel for more than it cost, he may say he has a jewel worth a thousand pounds, and had a thousand pounds in money; but his money being gone, instead of using it to his gain, he looks on his jewel with grief, especially when commanding necessity requires needful supplies: then lies his jewel dead, and cannot, but had he his money, it would have supplied his wants.

Purch. This, in mine opinion, is little to the matter in question, for I lay not out my money so, but that I have a yearly profit, answerable to the value of my money, and lies not dead, as does his jewel.

Surv. Little odds between nothing coming in, and something coming in and profit nothing; as doth your farm, which either wanting stock, can yield little, or having stock of interest, eats the gain. But the question propounded was, whether a man of small means were better for his profit to purchase fee-simple, or to buy a lease?

Purch. That, indeed, is the question, and I think a more profitable course, to purchase land in fee-simple, than to buy a lease.

Surv. I say, more expedient cannot be, for a man that hath ten, or twenty, or more thousand pounds in his purse; for thereby he may confirm his hope of hereditary succession, and consequently of honour and office. But to speak in answer to your stock, at the most (as you say) a thousand marks, were it two or three thousand pounds, I affirm these kinds of purchases are not most profitable.

Purch. What then, in your opinion, is the best course to lay so small portions of money in, as you speak of?

Surv. Leases.

Purch. Alas, a lease is gone in the third part of a man's age, unless it be for fifty, sixty, or a hundred years; upon such, a man might be content to lay out his money.

Surv. I hold rather a lease of one-and-twenty years more beneficial.

Purch. That were strange; how can you prove that?

Surv. Admit you have one thousand pounds in your purse, and you will purchase a lease of one hundred years. It will cost you thirteen years' purchase, at the least. So your thousand pounds will buy eighty pounds per annum, which will not amount unto the interest of your money by twenty pounds a year. But if you buy a lease of twenty-one years, you may have it for seven years' purchase. So will your thousand pounds buy a lease worth one hundred and forty pounds a year, exceeding the interest of your money forty pounds a year. So there are three score pounds more by a lease of twenty-one years, than by a lease of one hundred years, which whether it be more profitable for a man to buy that hath no great means, judge you.

Purch. Truly, for my part, I do now conceive it so well, as I am utterly dissuaded from purchasing land in fee-simple, or for more years than one-and-twenty, unless I had a greater portion than indeed I have. And, methinks, I might compare myself (in the mind that I was) unto one that had fourpence in his pocket, who would needs buy a purse to put it in, and so bought him a purse which cost him a groat; and he had as much money left to put in his new purse, as I should have had to have stocked my new farm, when I had bestowed my thousand marks upon forty pounds a year. But now buying a lease for one-and-twenty years, my thousand marks will bring me near three-score pounds a year, and yet reserve money sufficient to stock the farm. I do not think but if other men of my poor means did well conceive of this, they would be of the same mind that now I am.

Surv. I neither persuade nor dissuade any, to or from their own opinions, for, I know, it is as hard a matter to draw some men to a truth, as to remove some from an error. And some, I know, are always most persuaded to embrace that which is most in use, and refuse the better, that few affect, and not many have proved: and, therefore, to make a man's singular conceit (have it, in experience and practice, never so deserved an allowance) the precedent of other men's imitation, will suspend it until it become as common as vice itself; and, therefore, to yourself, I say, do not as I persuade, but persuade yourself, as your own conceit, in your seeming reason, shall tell you what is best or worst; though it be matter of fact, it is no matter of saving faith, therefore take right or left, as you list.

Purch. I am not so fickle in my fancy, as it should fly from one conceit to another, after such due satisfaction as you have given me: for, whatsoever other men's judgments may yield in this behalf, I take it the truest course for best profit by smallest means: and I think no arguments can be so forcible to remove what I have conceived. Only one scruple remains, which I may rather term a frivolous doubt, because it may succeed otherwise than I fear, and that arises, in my conceit, by reason of the shortness of the term of one-and-twenty years: for if a man leave his son a farm for that term, either it may be taken over his head, or else he must be forced to buy it again within fifteen or sixteen years, which both are things very unpleasant and distasteful to most men.

Surv. It is true; but the end of the term being truly known, it takes away some of the harshness, by a provident preparation against the time: for if a son to whom a man leaveth three-score pounds per annum (your own proportion) with a stock, if he, by his frugality, providence, and careful husbandry, cannot lay up in sixteen years so much as will either procure the same again, or some other as valuable elsewhere, leave him to live as he may after the term ended; for, it is not probable, that he would be thrifty or become more wealthy if he had thrice as much; for it is not the quantity of the thing left, but the quality of him to whom it is left, that proveth this proposition true or false.

Purch. It is so; for I have known some meanly left, with leases have grown rich, and some rich of inheritance, have become poor.

Surv. As are men's dispositions, good or ill, so, commonly, is the continuance of their estates prosperous or adverse.

Purch. Surely, it is true. It so appeareth by the carriage of young men in these days, who shew themselves most improvident and careless, for the most part, not only such as stand in possibility to be advanced by the ability of parents or friends, but such also (by a kind of impious imitation) as have no other means than either their own labours or sinister shifts; for as are the diseases of the body of late become yearly wonders for their strangeness, so men's profane humours and vicious qualities grow yearly more strange, by taking new courses of chargeable wickedness; changeable fashions in apparel, gaming, the pot, and their lascivious lives, rend patrimonies in pieces and bring men to mere beggary, that before scorned the mere title of gentlemen. A due observer may well note, that where one, left by a careful father wealthy, and, by the grace of God, is of discretion fit to manage what is left him, ten grow thereby the more insolent, secure, prodigal, vicious, and consume more in one year by their rank riot, than their careful fathers or regardful friends did get by their care and industry in ten; whereby groweth that strange vicissitude which we see in the world—

the father to purchase, the son to sell, the father to sell, the son to purchase, never continuing long in one line: many generations enjoy not one and the same inheritance. Patrimonies are like unto the feigned wheel of fortune, resembling also the waves of the sea, driven, now to the shore, and forthwith to the channel: as the tide and the winds, so are possessions posted from one to another, more in these latter days than ever before: minds, become inconstant, breed estates inconstant. In former ages an inheritance continued many generations, never altering either the line or the name of the owner; men had a kind of religious regard to preserve the inheritance of their ancestors, and in these days they think it a superstitious ceremony to keep it: the father buys in hope to better his son, and the son sells to dishonour himself; and, therefore, I think, whether it be fee-simple or lease, all is bait for a buyer, and a wasteful son is indifferent in both.

Surv. There is no cause so much to assure a son of future means by leases, as by fee-simples; for an eldest son is, in part, assured of his patrimony, howsoever he carry himself: but leases may be given as a chattel, and therefore may make a son the more awful. But it is a hard thing, that neither the love of parents in persuading, nor the law of magistrates by punishing, can prevent their daily increasing mischiefs: I think it may be affirmed that the fault is especially in parents, by giving and suffering, as also in magistrates, in not correcting such wilful transgressing the laws of love and obedience, and to shorten the line of that common liberty of young men whereby they live, do, and continue as they list; and so much the more, by how much they find their own strength, to rest in the ability and doting love of their abused parents, who (whilst they live), support these liberties by supplies of needless wants; and the hope of the whole after their parents' deaths, makes young men dive into the deepest of the danger of causeless debts, which (the parents dead) forces to be embowelled the best of his new-fallen patrimony, the relics whereof he must sacrifice to appease the violence of that devouring Hydra, and piece-meal offers the rest to his own vice and vain-glory.

Purch. Truly, these days affording such fruits, I wonder whether is more the cause, the folly of parents or the frenzy of children.

Surv. I think, indeed, many children (as it seemeth by their dissolute lives) are possessed with a kind of frenzy or madness; for they are as far from awe of government as are such as are mad indeed. And yet I think, of the two, the foolishness of doting parents is more the cause of their children's madness, than is the mere natural inclination of the children; for, did parents keep a kind of power in their own hands, and did not feed their children's humours too full, they could not but withdraw, though not their desires, yet their means from those wasteful courses.

Purch. It seemeth to me a matter almost impossible. My reason is, because it is now grown to so general a disease: if it were in the city only, and not in the country, or were it in one shire and not in another, or in one town or parish and not in another,—nay, were it in one house and not in another, I would then think the country might reclaim the city,—one shire, one town, or one house might reform another; but being as it is, so universal in cities, country towns, and houses, if any place or person be now free, it, or he, is in danger to be seduced; and, therefore, one father may endeavour by counsel, force, or fair words to order his son in the way of hope to be happy, but what ten fathers by counsel can work in two children in much time, one impious, idle, vain, and vicious neighbour's son shall poison twenty in less. And, therefore, unless, as the infection is general, there could be found a general preservative, it will grow, *ab hoc malo, ad illud pejus*, to be daily worse and worse.

Surv. So then let us leave them, and I leave you,—fare you well.

Purch. Nay, I must needs intreat your opinion in one thing more; I will not be tedious. When a man doth purchase land in fee-simple, or lease, are there not some special points of observation to be considered before a man either buy or sell?

Surv. I think none is so ignorant or simple, but if he buy a horse, he will see what pace he hath, whether he be sound, and whether he that sells him have right to the horse, and other circumstances fit to be considered in the buying of a horse. And will any man be so mad as to buy or sell land without due consideration, what he buys or sells? And yet, I must confess, that some do purchase, and some do sell, as they that cut wood over their heads, the chips fall into their eyes, they see not what they buy, or what they sell. Many have been and are daily deceived, for want of the true judgment of the things they buy or sell, not seeking to inform themselves by themselves; nor, for fear of charge, be informed by some of understanding, to view the thing they buy or sell, a matter savouring either of little providence, or great security.

Purch. Wherein I pray you should a man seek especially to be informed in buying or selling land?

Surv. Methinks it is a needless question, because these things are common to every man's conceit. But, to satisfy your desire, I take it, the title is first to be duly considered, and then the drawing of the evidence, for in these days there go more words to a bargain of ten pound land a year, than in former times were used in the grant of an earldom; and yet, methinks, many superfluous words might be omitted, and the assurance good, as they were in former times, with far fewer words, but that I leave to the learned, that know what is fit to be inserted or omitted, according to the quality of the thing purchased, only the true meaning should be the best assurance. Secondly, the yearly and likely permanent value is to be considered. The quantity, quality, and nature of the soil. The means to better it,—as by cleansing and clearing the grounds of bushes, and other inconveniences, draining of the low, boggy, and watery grounds; where, and how to get marl, chalk, moor-earth, sea-sand, and such like means, to improve and better mean grounds. The scarcity or plenty of wood and timber, which are either a help or hindrance to the sale. To observe the fences, and the means to continue them. The water, whether in springs, river, or standing pools, which last is most inconvenient. The housing, how convenient and competent they are, and how they stand presently repaired, and the supposed charge to do it. The situation of the place, for air, sweet or contagious. The ways, good or cumbersome, commons of pasture, commons of estover, if any be; what commodities it especially yields; how and where they may be best vented; and where, and how far off household necessaries are to be had. Duties to the church and commonwealth, with services due to the same; what issues out in rent, or other charges; what is paid to it; and many other things may be considered in the view of a manor, which at large are set down in the second and third books.

Purch. These are necessary notes of remembrance, which are fit to be considered, both by him that sells, and him that buys any land, the neglect whereof may prejudice either; and thereby no doubt many are deceived, and some abused. I am loth to trouble you further; I thank you for your patience; I will leave you to your occasions.

Prov. xvii, 2:—"*A discreet servant shall have rule over an unthrifty son*".

FINIS.

ORGAN

Detail of Organ in
St MARY'S CHURCH,
LUBECK.
1518

L. Gruner

ORGAN.

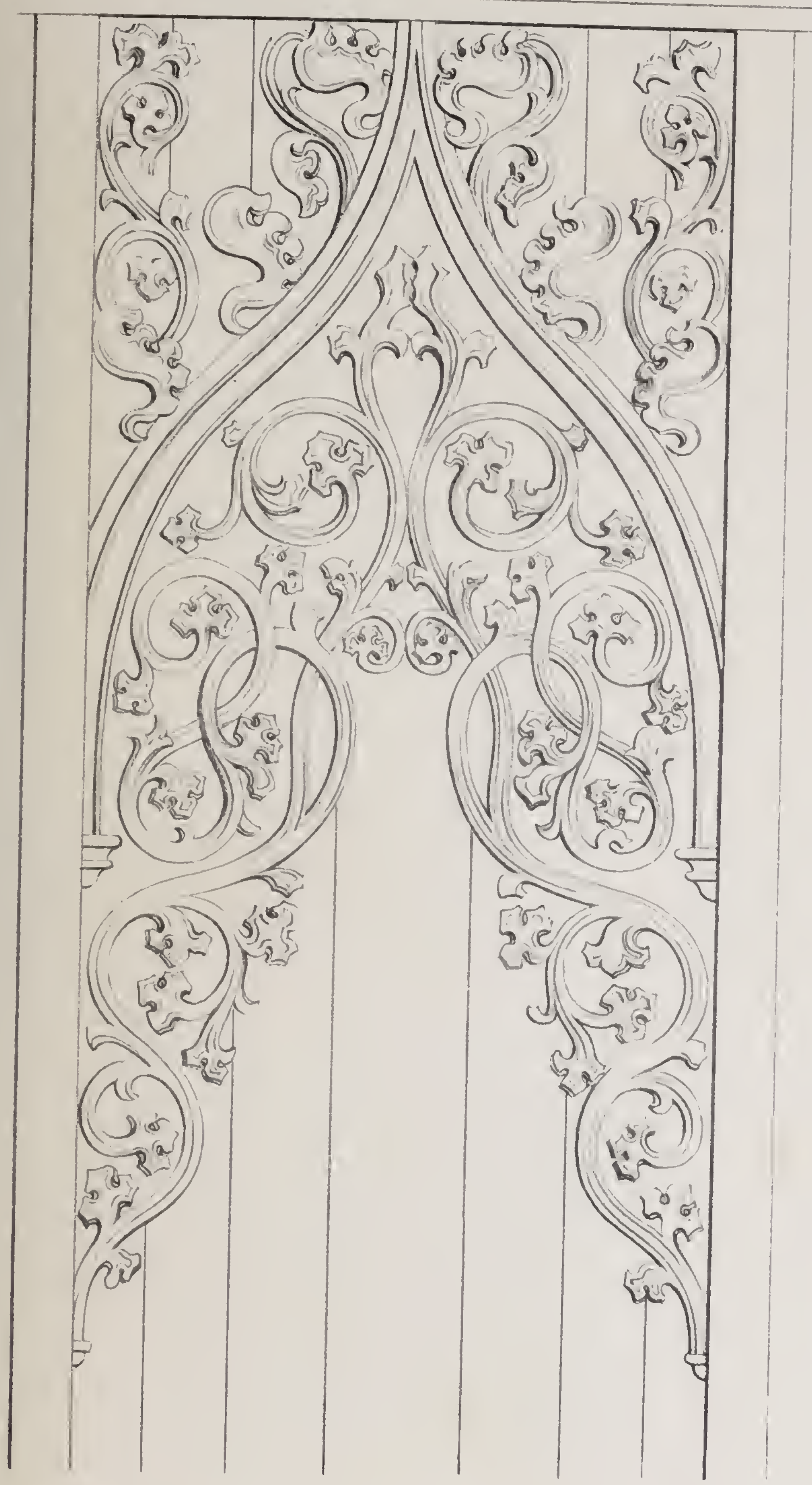
PLATE 3

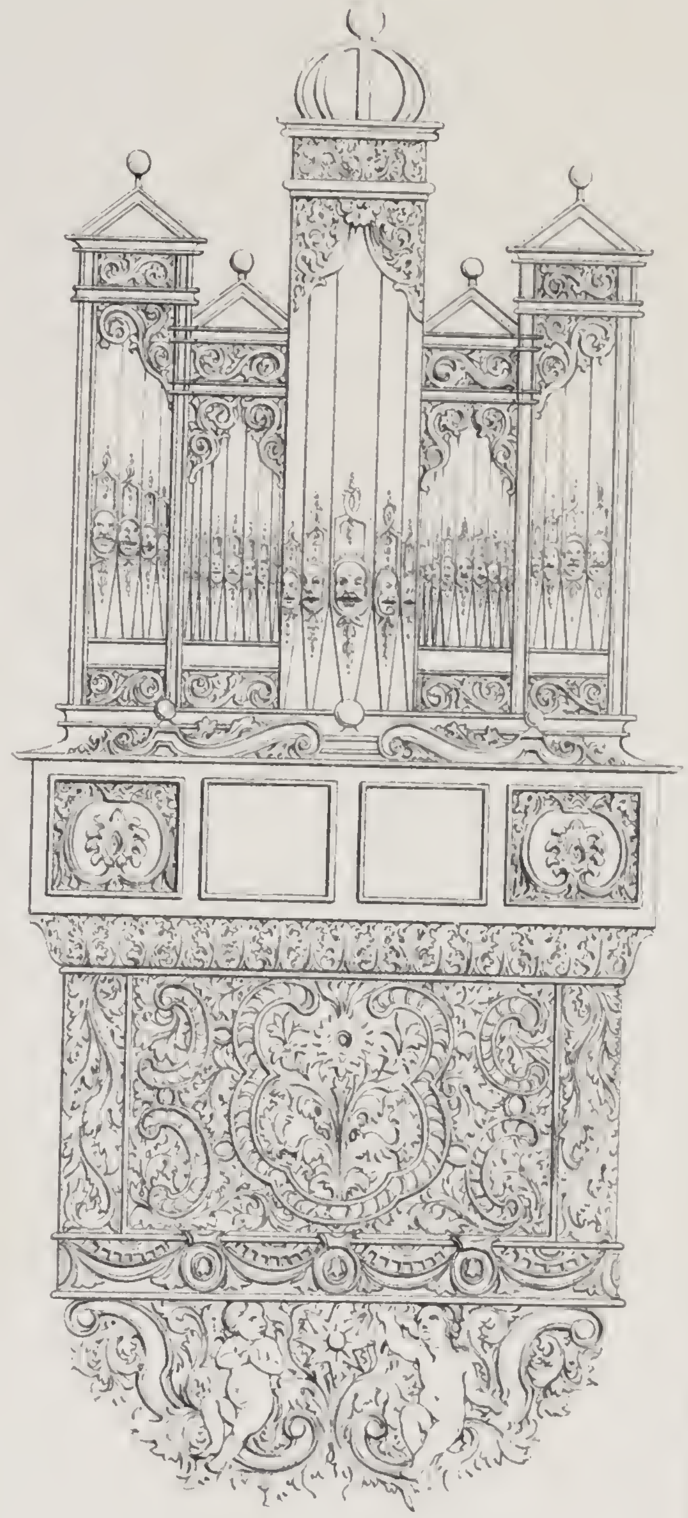
ST MARY'S CHURCH,
LUBECK.

Printed by Hullmandel & Walton Novr 1st 1852

ORGAN.

PLATE 4





St Mary's Church

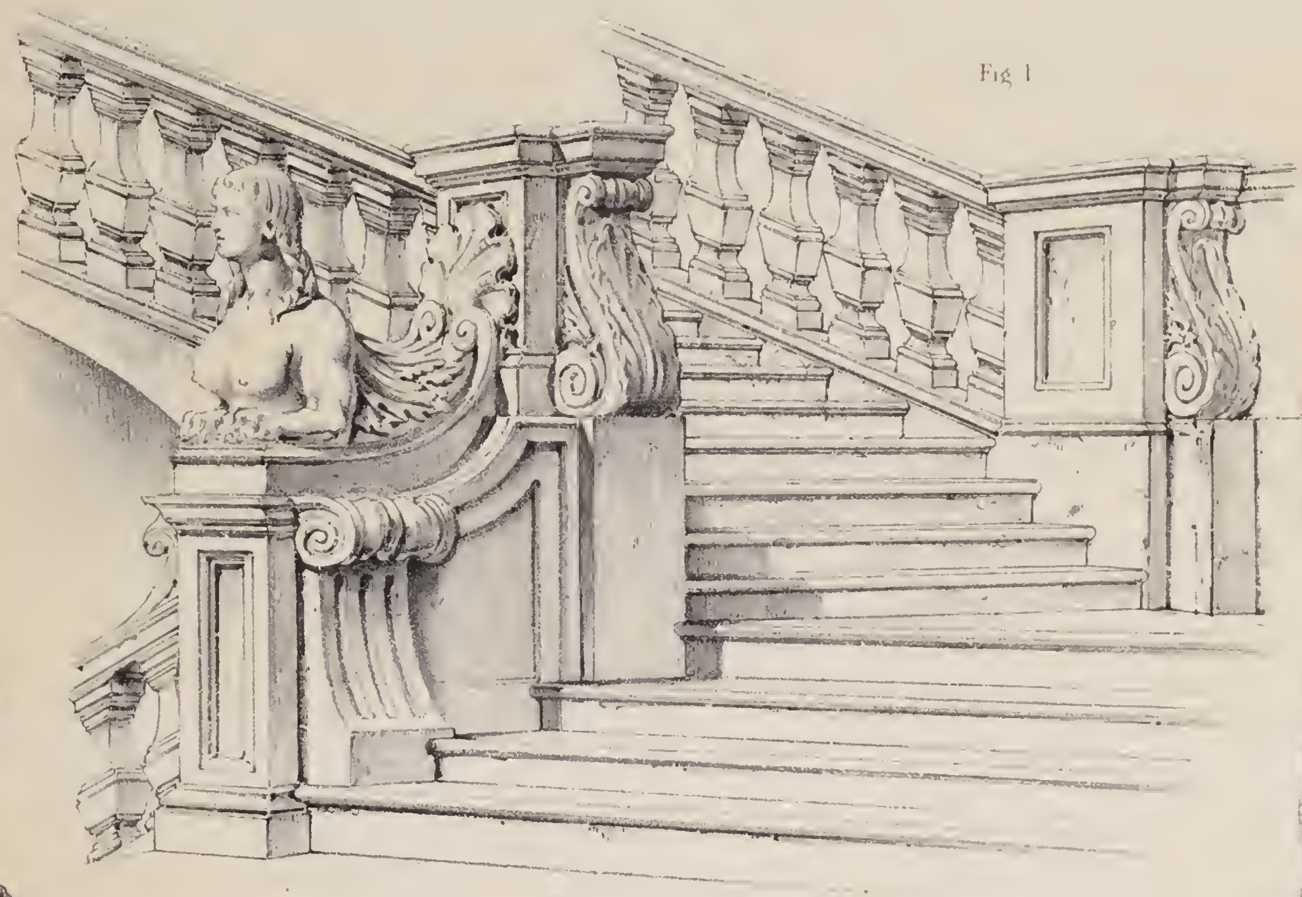
LUBECK.

Lithographed by P.C. Auld, Novr 1st 1852


SALVE

PEDESTAL.

Fig 1



PALAZZO BOROLO. TURIN.

John Johnson F.S.A.

2

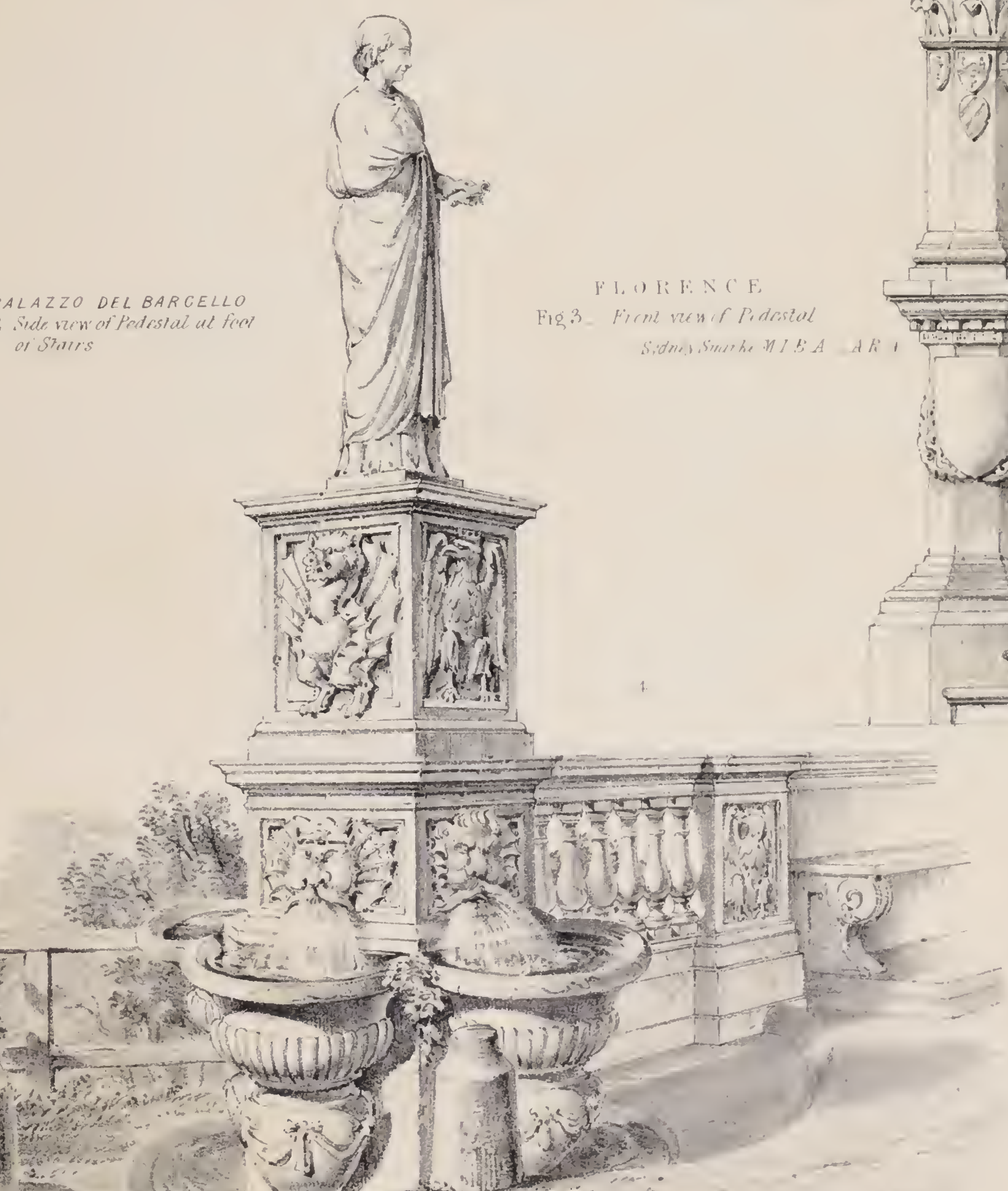
PALAZZO DEL BARGELLO
Fig. 2. *Side view of Pedestal at foot of Stairs*

Scale ½ in. to a foot

3

FLORENCE
Fig. 3. *Front view of Pedestal*
Sydney Smirke M.I.B.A. A.R.A.

4



BORGHESE GARDENS. ROME.

Rowland M.I.B.A.

OBSERVATIONS
ON PEDIMENTS,

WITH

A GENERAL METHOD

FOR

DETERMINING THE PROPORTIONS OF THAT PART OF EDIFICES.

BY

C. STANISLAS L'ÉVEILLÉ.

INGÉNIEUR-EN-CHEF DES PONTS ET CHAUSSÉES.

With Illustrations.
(Plate 27.)

Etudiez premièrement la science, et puis suivez la pratique, qui est une effet de la science.—LEONARD DE VINCI.

PARIS, 1824.

ON THE ORIGIN OF PEDIMENTS.

THE generality of houses in Rome were covered by platforms; only the edifices consecrated to the gods were surmounted by raised roofs, and Cæsar was the first person allowed to raise a pointed roof to his dwelling similar to those of the temples.

It is not long since, that in France, a gable over the street was the indication of a considerable habitation, and it is possible, that from this distinction, which was affected in the form of the roofs, the extreme loftiness of the edifices called "Gothic", and thence the form of its pointed arches, may have resulted.

Whatever may be the degree of importance attached to this form of roof, the Greeks, among whom it was first employed,[1] were forced, in order to terminate the extreme ends of their buildings with dignity, to design the pediments, which crown so elegantly the temples of their gods (fig. 1, Plate 27); and it would not perhaps be unreasonable to suppose, that if the triglyphs of the Doric frieze, the first order in use amongst these people, had not demanded the return of the whole of the entablature, they would have left plain, or adorned only with bas-reliefs, the space between the architraves and the sloping cornices (fig. 2).

ON THE PARTS OF PEDIMENTS.

In a pediment there are three parts to be distinguished, namely, the tympanum A, the cornice B, and the acroteria C C (fig. 4), a species of pedestal without base, used by the Romans in particular, to receive statues.

ON THE HEIGHT OF PEDIMENTS.

From the small height which Vitruvius allows to the pediment, it is evident, that this author specially followed the Greek monuments, in determining the proportions of this part of buildings. The Roman Architects not only considerably deviated from his rules in this respect, but, forgetting the first intention of the pediment, employed it to decorate doors, windows, and interior niches (fig. 15), sometimes even changing the original triangular form into the segmental (as we see in the small altars of the Pantheon at Rome, fig. 21), or giving it a bizarre shape, as at Palmyra and Baalbec.

According to Vitruvius, the height of the tympanum (fig. 4) should be equal to the ninth part of the length of the corona, from one extremity of the cyma to the other;[2] but the successors of this Architect, finding such pediments too flattened in appearance, have laid down other rules, of which the least inconvenience is, that they all differ; thus, Scamozzi directs that the height of the pediment should be, to its apex, 2-9ths of its base; others, again, give but 1-6th to this height; others, 1-7th; at the present time, Architects seem to confine it between 1-4th and 1-5th (DURAND, *Leçons d'Arch.* vol. i, p. 81); Serlio, lastly, has taught a graphic method, which consists in dividing the length Q T, of the horizontal cornice or base of the pediment (fig. 12), into two equal parts, by a perpendicular line V X, making A X equal to A T, or A Q; and from the point X, as a centre, with a radius equal to Q X or T X, describing the arc Q Y T, which determines the point Y on the perpendicular V X, as the apex of the pediment.[3]

It appears to me, that none of the rules proposed, whether by Serlio, Scamozzi, or any other master, have an application sufficiently general to give them the preference over that laid down by Vitruvius (to which, however, they approach closely in edifices of small width); but if the methods of Serlio and Scamozzi differ but little from the principles by which the admirable proportions have been determined, both of the pediments which surmount the small bicolumnar altars in the Pantheon, and that of the octostyle portico of the same magnificent building; how, were we to follow the rules of these masters, should we determine the proportions of the pediment to a decastyle portico, such as we may presume to the temple of Apollo Didymæus, near Miletus, or, to an edifice which, like the frontispiece of Nero at Rome, would have had, according to Palladio, twelve columns in front?

In applying these rules to different porticos (fig. 23), we see that even in the decastyle, the height of the pediment with that of the entablature, would together exceed that of the columns, even if Corinthian, and that this excessive height would increase still more, progressively, and in manner perfectly inadmissible, in proportion to the greater number of columns.

Surely then, in these extreme cases, the rule of Vitruvius would be preferable to all the others, as we can see from the same figure (23), where the results are indicated in dotted lines; and these results, which are not without examples, would apply equally to the Pantheon of Hadrian at Athens, and to the temple of Apollo instanced above, both decastyle, and of which the tympana would have, the one rather less, the other rather more in height, than the ninth part of the length of the horizontal cornice.[4]

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[1] The Corinthians were the first to cover their temples with ridged roofs. (*Blondel, Cours d'Arch.* P. 2, B. 7.)

[2] The cymatium of the corona must not be confounded with the great cyma, which, according to Vitruvius, should surmount only the cornices of pediments, and thus not be applied to horizontal cornices, except when they are lateral, or when they pertain to designs which have no frontispiece.

[3] We must not lose sight of the fact, that when the height of the pediment is mentioned, such height is taken, exclusive of the great cyma.

[4] The examples are taken from DURAND's *Parallèle des Edifices anciens et modernes.* It is from this work, also, that

If, also, we compare the rule of Vitruvius with the octostyle temples of the ancients, we shall see that the height of the tympana to those of Jupiter Tonans, Neptune, Jupiter Stator, the basilica of Antoninus, etc., would be at the utmost 2-15ths of the length of the horizontal cornice, a proportion differing but little from 2-18ths. Lastly, the less number of columns the façade possesses, the nearer does the rule of Vitruvius approximate to those of Serlio and Scamozzi, as can be seen from figures 4 and 22.

These rules appear to be all founded on the declivity which each of these authors has judged the most suitable to give to the slope, for the purpose of obtaining therefrom the prompt discharge of rain-water. Vitruvius is perhaps the only one, who, inhaling his principles under the pure skies of Greece, had possibly but little regard for this consideration, and has therefore fixed the height of the tympanum at the ninth part only, conformable to the noble examples he had before his eyes.[5] But in Italy, where the more continuous rains demand proportionably elevated roofs, it became necessary to abandon the Greek model adopted by Vitruvius, and in lieu thereof to follow the rule of Scamozzi, who apportions to the height of the pediment 2-9ths of its base; or that of Serlio, who allows rather less than the same result. Under the watery skies of our climate, we are compelled to increase this height still more, and some Architects, as Fontana, have not feared to raise it even to one-fourth.

Rules based on local considerations, may sometimes hold the position of principles; but it appears to me, that (without blaming modifications, which peculiar circumstances may authorize,) it is not the less useful to seek to fix these principles, and, when they are recognized, to establish their authority, by general rules.

Now the chief inconvenience attending the rules proposed after the time of Vitruvius, consists in the uniform inclination of the cornices of all the pediments, whatever may be the number of columns which they surmount; and this uniformity nowhere presenting itself in the works of the ancients, in which the cornices of the pediment are so much the less inclined to the horizon, in proportion as the façades contain a greater number of columns, it would appear that none of these modern masters in the art had sufficiently studied the question, and that, therefore, the general law from which to determine the proportions of pediments, remains still to be discovered.

Awaiting a more ample solution of this problem, I venture to offer the results of some reseaches in which I have been engaged, from the necessity of obtaining a method applicable to all cases.

METHOD FOR DETERMINING THE PROPORTIONS OF PEDIMENTS.

Let A (fig. 9) be a tetrastyle portico of the Ionic order, raised according to the proportions of Vignola, and *a b* the total length of the horizontal cornice which forms the base of its pediment. If, from the points *a* and *b*, taken successively as centres, and with a radius equal to the total length *a b* of the cornice, the arcs *a x*, *b x*, be described, the intersection of these arcs on the perpendicular, V X, will give at *x* a point, from which, as a centre, and with the same radius *a b*, may be described the arc, *a y b*, which, at *y*, will determine the height of the tympanum.

Above, and from this point *y* as a centre,[6] and with a radius *y g*, equal to the depth of the horizontal cornice,[7] describe a portion of a circle *f d g*; from the extremities of the horizontal cornice *a* and *b*, draw the tangents *a d*, *b d*, which will be the uppermost inclined line of the cornice of the pediment; it then only remains to add as many more lines parallel thereto as are necessary—those beneath, to express, in their relative positions, the members of the cornice—those above, to represent the great cyma.

If we determine in the same manner the height of the tympana, and the inclination of the cornices of the pediments, of the octostyle and dodecastyle porticos B and C (fig. 9), of which the length and depth of the horizontal cornices are given, it will result, that the successive heights of such pediments will diminish progressively, in proportion to the greater number of columns, and in accordance with a law which seems to meet the demands of the case; for not only does it avoid that want of elevation, in porticos of few columns, which constitutes the fault of the pediments of Vitruvius, but also, if we select examples, it agrees with the other rules.

Thus, in a porch of two Ionic columns, raised according to the proportions of Vignola's portico without pedestals (fig. 8),[8] the total height of the pediment under the great cyma is between one-fourth and one-fifth of the length of its base, a proportion adopted by modern Architects, and approaching very nearly to the 2-9ths of Scamozzi: in the tetrastyle A, this height does not differ sensibly from that obtained by Serlio's method;[9] on the

adopting, without discussion, the denominations therein given to the different monuments, comparisons are established, and proportion founded on the restorations.

[5] The portico of the Ionic temple near the Ilissus, according to Stuart, is an example; and if the tympanum of the portico of Athens has one-eighth in height, that of Minerva Polias, has but a sixteenth at most.

[6] Vitruvius, in prescribing the height of the tympanum, does not point out the method of determining the inclination of the slope of the pediment. Although it might be extremely simple and easy to comprehend, it would not have been altogether useless to have mentioned it. It must be the same as that which we here employ, indicated at fig. 4, by the portion of a dotted circle marked *c p v x q* (and fig. 9, *f d g*).

[7] We know that the horizontal and sloping cornices of modern pediments are usually alike, and equal one to the other. This rule is not binding, the less so, inasmuch as it is contrary to principle, as we shall see hereafter; and as, in many cases, its application engenders serious difficulties.

[8] I have deemed it better to select the Ionic order of Vignola, as an example of the method I propose; first, because it seemed to me to be the purest and best proportioned of the five orders of this master, and, especially, because the projection of its cornice (without including the great cyma) and its depth, hold a medium place between the heights and projections of the cornices to the other orders; which is by no means unimportant for our purpose, as these proportions influence very perceptiby the data which serve as the base for our operations.

[9] It has been remarked, that the angle of the apex of pediments constructed after the method of Serlio, is equal to the angle *p q r* in the circumference of an octagon, X (fig. 12), since, in fact, the point X being the centre of the arc Q V T, which has been described, the two radii, X Q and X T, form a right angle (BELIDOR).

In making an analogous remark on the elements of this new method, we might be tempted to believe that, having constructed the dodecagon X (fig. 9), the angle at the apex of all pediments would be equal to the angle *p q r* of this polygon, which is not, however, the case, and could only be so, in fact, if the inclination of the cornices of these pediments were parallel to the sides of the dodecagon.

But it is not so, and it is in this very particular that the proposed method differs essentially from that of Serlio and all others invented since the days of Vitruvius; for, by means of the arc *g d f* (of which the radius is equal to the height of the horizontal cornice, and the centre of which is on the arc *a y b*, at the point *y*, the apex of the tympanum), all parallelism to the side of the polygon X is avoided, in proportion as the base of the pediment is less in length; as we may convince ourselves by examining fig. 10, where we see at once that the nearer the radii *d a*, *d b*, etc., perpendicular to the tangents *a* 1, *b* 2, etc., incline to be parallel to the horizontal line L M, the nearer the tangents incline to be parallel to the vertical P N. This peculiarity of the new method gives it also the advantage over the others in this respect, that the longer the radius of the small circle *g d f* (fig. 9), the more the slope of the pediment increases; which

other hand, in hexastyles, octostyles, etc., it ranges between a sixth and a seventh, proportions prescribed by some Architects, and supported by numerous ancient examples.

This, then, is the general method which I propose to adopt.

ON THE CORNICE OF PEDIMENTS.

In speaking of the origin of pediments, I have supposed that the necessity of retaining the triglyphs, which are the chief characteristic of the Doric order, may have prevented the suppression of the frieze and horizontal cornice of the façade of temples;[10] and to this motive we may add the difficulty which presented itself, in the return of the horizontal members of the cornice on the lateral faces, following the inclination of the pediment; for the return, as indicated at A, fig. 14,[11] could not be executed; and to make the lateral cornice in the manner in which it is shown at fig. 13, it would be necessary in some measure to make the art retrograde, a hazardous enterprise to undertake, since architecture, raising magnificent monuments, must have long since lost sight of the humble cabin whence she took her rise.[12] This difficulty of the return of the cornices, which disappeared by the retention of the horizontal one, reappeared later, when the great cyma was considered as an essential member in cornices,[13] and that of pediments only as its prolongation; but the curvature of this cyma rendering it less in length at its lower than at its upper part (fig. 6), this difficulty was surmounted by making the cyma of the pediment higher than that of the lateral cornices;[14] and when the pediment (through a novel abuse of proprieties) crowned only one portion of the façade, some modern Architects contrived a projection (fig. 7), which preserves the same thickness to both cymas; whilst others, to allow only the just proportion to the cyma of the pediment, have preferred to diminish the height of the lateral cymas (fig. 7). This method appearing the most reasonable, is the one I propose to adopt. The Greeks, seeing no affinity between the slopes and the eaves of their roofs, did not apparently attempt to constitute any between the cornices of the lateral faces which terminate the eaves, and those of the pediments which terminate the slopes. Hence the great simplicity of these last in almost all their monuments, and the constant suppression of the mutules in cornices of pediments to the Doric order, as in the portico of the temple of Theseus, and that of the Parthenon at Athens.

The Romans believed that these cornices should be alike; and in adopting particularly the modillions and dentils with which they enriched the cornices of their sumptuous edifices, took great care not to suppress them in cornices to pediments, as the fragment of the frontispiece of Nero evidences. Modern Architects have followed their example: and fig. 22 is a design for a pediment surmounting a tetrastyle Corinthian portico, according to the proportions of Vignola. Therein we see the modillions and

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settles the question; whatever may be the length of the bases, whatever may be the proportions of the cornices.

[10] BLONDEL, in treating on the defects of pediments, observes, that, in order not to swerve from the severity of nature, we ought to omit the horizontal cornice to façades where there are pediments; and elsewhere cites some examples of this kind, taken from ancient edifices, and particularly from the baths of Diocletian. It is impossible to agree with Blondel, if we reflect that the ancients have never omitted to put the horizontal cornice to the frontispiece of temples. It might also be objected, that the rampant cornices which terminate the gables of the halls in the baths, basilicas, etc., are by no means pediments. The observation is at least open to discussion. It rests with professors to rectify, if necessary, the consequences of Blondel's opinion in this respect.

[11] With a little attention, we shall observe, that in this case the return of the soffits of each member would in itself form a species of molding, as is expressed at B in the same figure.

[12] The inclination of the soffits of the cornice exists in the coronas of most of the ancient Doric temples, as in the great temple at Pœstum (fig. 19); and is found at Rome, in the Doric entablature of the theatre of Marcellus (fig. 17). In the temple of Segeste (fig. 20) this inclination does not appear to differ from the mean slope of the pediment; to these particular observations, we may add some, made on the spot by Le Roy. This architect remarks, that, according to Vitruvius, "the mutule was imitated from the projection of the roof timbers," which is better proved by the fact, that the face of the mutule, from which depend the guttæ, is inclined in the temple of Theseus, in precisely the same degree as are the sides of the pediment. This temple was erected about ten years after the battle of Marathon, and apparently served as a model for the temples and most celebrated edifices which were constructed at Athens, some short time after, under the government of Pericles. This conclusion as to the origin of cornices, as so many other types, still remaining, of those of the different parts of the Greek entablature, causes a regret that, in our time, some Architects affect so decided a contempt for the wooden prototype; the more so, if we consider that it is ever for those monuments, which bear the greatest affinity with the unity of its whole, that we express the most unanimous admiration.

[13] There was no great cymatium to the side cornice of the temple of Minerva (fig. 16), nor was there any even to the cornice of the pediment of the temple of Theseus (LE ROY).

[14] Here particularly, it may be observed, how much during these latter ages, architecture has wandered from its principles; for, amongst the ancient Greeks, the horizontal cornices were only a simple corona with its mutules, the soffits of which, inclined conformably to their origin, threw off the rain-water far from the walls of the building (DURAND's *Parallèle*, pl. 63 and 65). The corona was surmounted solely by a fillet or small cyma (figs. 19 and 16), the thickness of which received and concealed the ends of the roof-tiles, the members below the corona belonged evidently to the frieze. At a later period, the origin of the cornice being lost sight of, the mutules were suppressed; the inclination of the soffit being replaced by a sunk planceer (*refouillements*), which sinking was made good by the introduction of another small cyma, between the soffit and the frieze. I have before mentioned what was the intention of the great cyma, which from the cornice of the pediment, passed afterwards into the lateral ones. Such was the state of deviation from the principles of architecture, when the Romans, after conquering Greece, transplanted the arts into Italy. That nation, far from regarding these first secessions as abuses, believed themselves aiming at perfection in adding new, but motiveless detail, to the already too much encumbered cornices, the corona of which, ere long, subsided into one of the least important members; as may be seen in the entablature of the temple of Fortuna Virilis (fig. 11).

Modern Architects, in prolonging the roofs beyond the great cyma, have rendered the corona altogether as useless as the other moldings, the combinations of which they have capriciously varied; so that had they not retained the sunk planceer, we should with difficulty recall the original destination of this essential part of the cornice, and it would have been better to have suppressed entirely the pendant fillet (*mouchette*), as this extra labour tends only to augment the confusion in the unpleasing projections of their profiles.

"It is also a truth in architecture," says QUATREMERE de QUINCY, "that its charms have originated with its necessities. Of this, the Egyptian entablature offers an example. This part, so beautiful and so rich in Grecian architecture, owed its richness and beauty to all those essential accessories to which the necessary corelations of the soffits, beams, and rafters of the roof, and coverings, had subjected both the model and its copy. Egyptian architecture, necessitated by its imitative principle (grottos) to fewer requirements, drew its origin from a source less prolific of beauties, etc." (QUATREMERE, part ii, p. 118).

dentils of the horizontal cornice repeated in the cornice of the pediment, in which they are placed perpendicular to the first; but we shall moreover remark, that one portion of these ornaments is traced vertically, and the remainder perpendicularly, to its slope. This last method has been devised only by some modern Architects,[15] who, desiring to appear scrupulous about principles, have pretended thus to approach nearer to the origin of modillions, imagining that they recognized in them those timbers of the roof, which are usually at right angles to the slope.

The Romans, more wise, having once entirely abandoned these principles, have not affected a return to them, but have made the lateral faces of their modillions and dentils vertical. Having departed so far from the Greek principles, it is, then, the Roman monuments which we must adopt as models; or, if we hesitate here, it would perchance be preferable to suppress these ornaments entirely in the cornices of pediments, reserving to oneself the power of replacing them with sculptured mouldings;[16] or, better still, to diminish in the same proportion the number of members under the corona, a simplicity which would the better suit the cornices of tympana, inasmuch as these last are sufficiently adorned with the bas-reliefs, with which it is the custom to decorate them.

And now, in closing my remarks relative to the cornices of pediments, I have but to repeat here the principle adopted, viz., that such of the members as are a repetition of the members of the horizontal cornice, should be equal to these last, both in projection and height, and that to fix the proportions of the cornice of a pediment (fig. 22), it is necessary to make it follow a line *a*, *b*, perpendicular to its slope, and equal to the right line A, B, which embraces all the members of the horizontal cornice, and, in this particular instance, the astragal that Vignola made dependant upon the frieze.

ON THE ACROTERIA.

The centre Acroterium,[17] or that which is placed on the apex of pediments, is to be distinguished from those which are situated at the extremities of the slopes. The plain faces of both one and the other[18] are always, in modern architecture, flush with the upper diameter of the columns, and therefore necessarily in line with the plain face of the tympanum, frieze, and entablature (figs. 5 and 3).

The acroteria at the angles can be made either square (c, fig. 4), to receive a single figure only, or be prolonged up to the slope of the pediment, for the purpose of supporting groups.

They are usually capped with a small cornice, consisting either of a simple band, or, more frequently, of a cornice analogous to that of the pedestals of the order to which they are applied. According to Vitruvius, the height of the angle acroteria should be, exclusive of the cornice, equal to that of the tympanum of the pediment they surmount; whilst the one in the centre should exceed those at the extremities by 1-8th of their height; the cornice to both being 1-6th of the height of those at the angle: but this rule is applicable, at the utmost, to tetrastyle façades, and cannot be so to those which embrace a larger number of columns, since, as the height of the tympanum increases in ratio with the length of the base of the pediment, it would follow that the angle acroteria would form a species of high wall upon the pediment, similar to that which is shown at fig. 12, Q P Y.

Scamozzi has, in consequence, found it more suitable, as it is in fact more reasonable, to make the height of the acroteria depend on the proportions of the cornice of the pediment to which they appertain, the cornice itself being in relation with the rest of the order. Treated thus, the greatest height of the angle acroteria, with their cornice, will be equal to the projection of the cornice of the entablature; that is to say, *m n* will be equal to *k l* (fig. 8); and the central acroterium will be in height 1-8th more than those at the angles.[19]

JAMES M. LOCKYER.

[15] MANSARD, in the pediment of the church of Ste. Marie, Rue S. Antoine; GITTARD, in the lateral entrance to S. Sulpice, Paris.

[16] PALLADIO cites an example of a pediment in the town of Schisi, the pendant cornice of which is without modillions, although the others which are level, have them. In lieu of modillions, there is a great cyma covered with foliage (PERRAULT, *Vitr.* b. 2).

[17] With the exception of the portico at Athens, upon which, independently of two small bases, scarcely visible, at the extremities of the slopes of the pediment and on the same line with the frieze, we see at its summit a species of large pedestal, (which Stuart supposes to have been surmounted by an equestrian statue of Lucius Cæsar), and which has some affinity with the acroterium on the apex of pediments, we find no proof that the Greek temples now remaining were surmounted by statues above their roofs: it was only later that they crowned their buildings with figures in terra-cotta, such as those which, according to Pausanias, were on the summit of the royal portico, representing Theseus precipitating Sciron into the sea, and Aurora carrying off Cephalus (*Voyages d'Anacharsis*). The Romans, on the contrary, surmounted all their edifices with statues; and thus, these conquerors of the earth, after dedicating altars to their emperors, and replacing in the sanctuaries the statues of Jupiter, Optimus Maximus, with those of Octavius and Nero, banished the images of their gods to the tops of their temples; where, little better than sign-boards, they soon received the smoke alone, which escaped from the sacrifices lavished upon the idols of a shameful adulation. Hence originated these mutilated pedestals, which seem scarcely to rest on the sides of the pediment, and which Vitruvius finding in vogue in his time, regarded as an essential accessory to this part of edifices.

The acroteria of Roman buildings have been imitated by modern Architects: but, in our time, it seems the example is no longer followed; and if, in some cases, it may have been deemed convenient to preserve those of the angles, because they accord with the pedestals or plinths, with which it has recently been the fashion to decorate the lateral entablatures, the central one, at least, has been suppressed, Architects contenting themselves with expressing, either by bas-reliefs in the tympanum, or inscriptions on the frieze, the dedication of the building, or the munificence of its founder.

[18] In the portico of Athens, the angle acroteria are very slightly elevated, and bear almost entirely on the cornice. There are similar small acroteria to the temple of Minerva; but neither examples having any true bearing, it is impossible to believe that they were destined for the reception of statues.

My only acquaintance with the last-mentioned acroteria is from the work by Le Roy; and remarking therein, that their length is only consequent on the very slight return of the great cyma, I conceive that these small plinths (which were moreover concealed from view, by the projection of the cornice) were intended solely for the reception of the rain-water, to collect, and carry it off by means of the lion's head, visible only at each extremities of the lateral cornices of this temple.

[19] This rule of Scamozzi is cited by BLONDEL (*Cours d'Architecture*), in which work the author, notwithstanding his explanations, is too often not sufficiently precise in points constituting the object of the question he discusses. Thus, in making the height of the angle acroteria equal to the height of the cornice, we are not informed whether we must include in this projection that of the great cyma; which I consider should be the case: again, we know not whether this height should be taken above the horizontal cornice, or from above the slope of the pediment; I believe the latter: nor do we learn the exact proportions to be allowed to the cornice of the acroteria, when we read only that such cornice should be proportioned to the height of the die.

These proportions I have herein endeavoured to fix; and have done so without discussion, because I should otherwise have lengthened, without any increase of utility, a paper already sufficiently long; and before the publication of which, the erection of a large number of noble edifices tended to prove, that masters in the art have by no means absolute need of fixed rules to do well.

PEDIMENT.

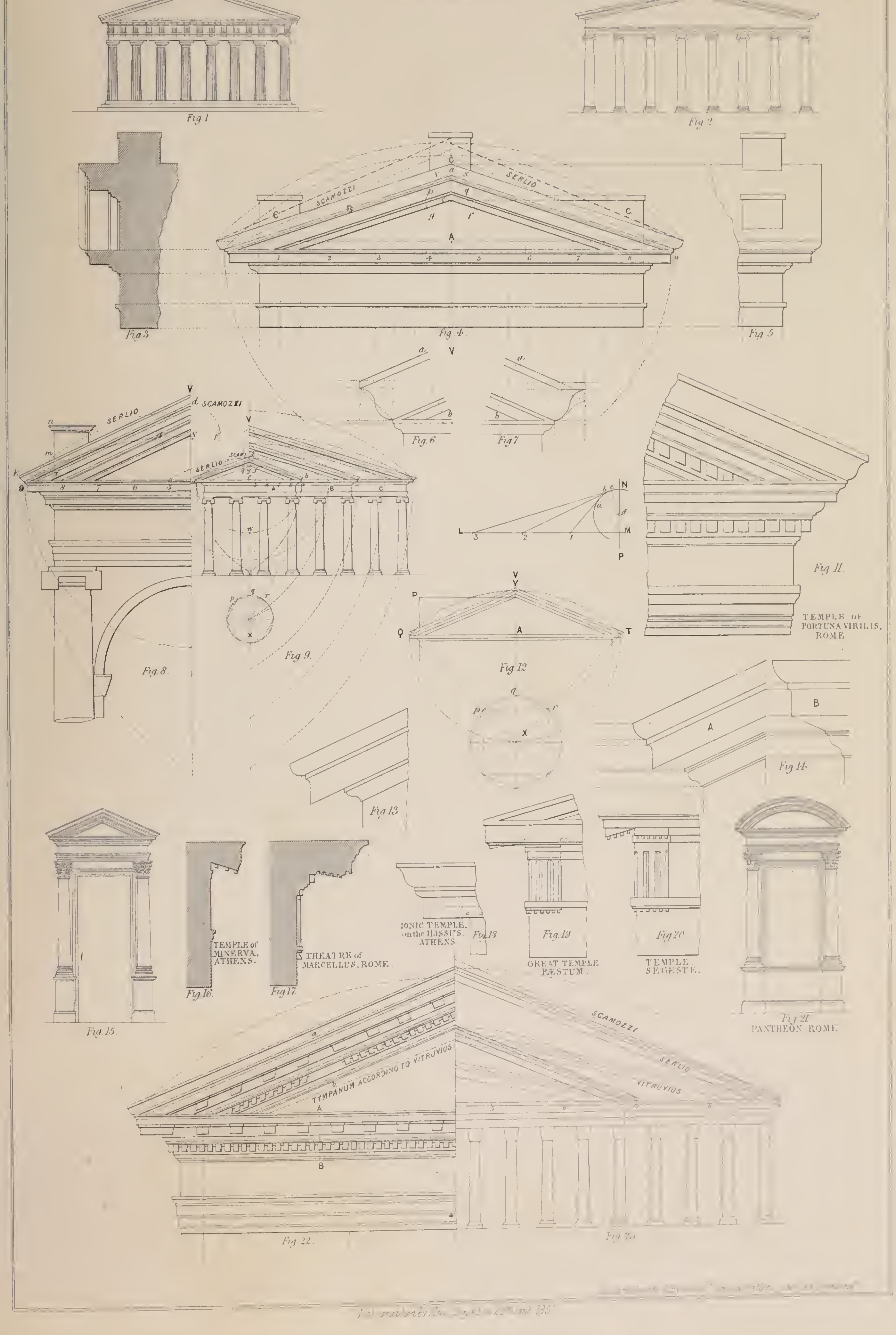


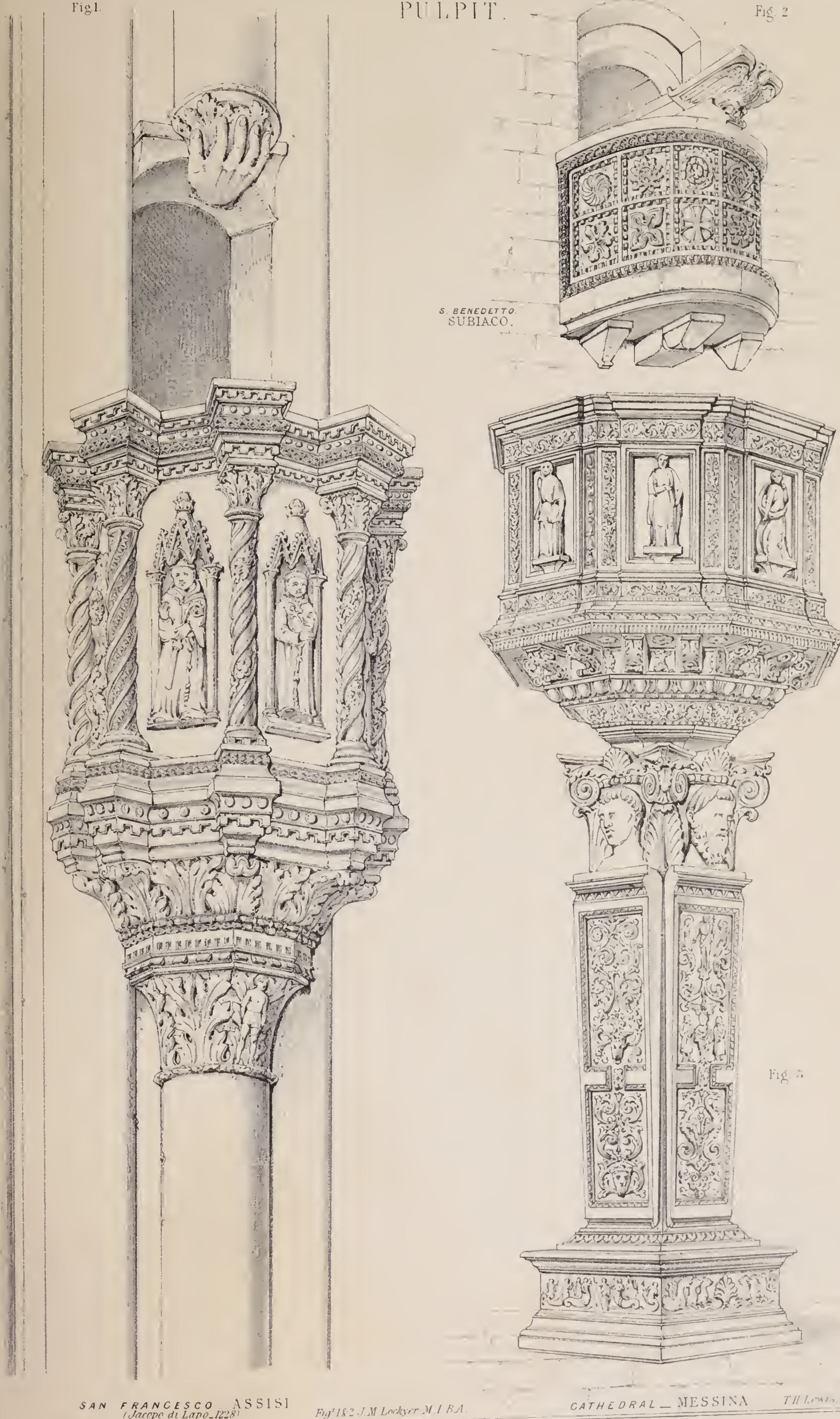
Fig 1
Fig 2
SCAMOZZI
SERLIO
Fig 3.
Fig 4.
Fig 5
Fig 6.
Fig 7.
SERLIO
SCAMOZZI
Fig 8.
Fig 9.
Fig 11.
TEMPLE of FORTUNA VIRILIS, ROME.
Fig 12
Fig 13
Fig 14
TEMPLE of MINERVA, ATHENS.
THEATRE of MARCELLUS, ROME.
IONIC TEMPLE, on the ILISSUS ATHENS.
Fig 18
Fig 19
GREAT TEMPLE PÆSTUM.
Fig 20
TEMPLE SEGESTE.
Fig 15.
Fig 16.
Fig 17.
Fig 21
PANTHEON ROME.
SCAMOZZI
SERLIO
VITRUVIUS
TYMPANUM ACCORDING TO VITRUVIUS
Fig 22.

PIAZZA.

Lithographed by Mess.rs Day & Son, April 30th 1850

PULPIT.

Fig. 1. Fig. 2



S. BENEDETTO. SUBIACO.

Fig. 3.

SAN FRANCESCO ASSISI (Jacopo di Lapo_1228) Fig^s 1 & 2 J. M. Lockyer M.I.B.A.

CATHEDRAL _ MESSINA T. H. Lewis. M.I.B.A.

ECCLESIASTICAL SCULPTURE

Fig 1

S^T MARK VENICE

Fig 2

CAMPO SANTO_PISA

Fig 3

S^T MARK VENICE

Fig 4

Mural Painting
S FERMO VERONA

Fig 5

Mural Painting S FERMO_VERONA

Fig 6

Canopy S ANTONIO PADUA

Fig 7

Elbow of Stall
S ANTONIO_PADUA

RIDGE.

(ORNAMENTAL).

PLATE LXXXI.

THE following observations, and the accompanying examples, have been taken from the work by E. DE LA QUÉRIÈRE, entitled, *Essai sur les girouettes, épis, crêtes et autres décorations des anciens combles et pignons, etc.*, 8vo., Paris, 1846, and it has appeared better to separate them under distinct heads, than to leave these subjects as they were originally grouped by that author. The plan adopted, has the advantage of presenting at once the system of decoration practised formerly both upon the lead-work of the ridges of roofs, and upon the metal, tile, or stone ornaments which form the crests of such ridges. The word *crête,* as applied in France to denote the result obtained by placing curved tiles upon a ridge, is indeed expressed, particularly in the south of England, by the term tile-cresting; but as this expression is one generally used to denote an employment of plain tiles ("cresting" or "creasing"), it has been avoided throughout the following translation by the use of the word "crest", which also serves for an equivalent to the French term *dentelle,* indicating the indented character of the sky-line produced in the mediæval crests.

Our professional predecessors employed for the ornamentation of ridges a magnificence, of which an idea can hardly be formed at a time like the present, in which things are measured by the sight alone; this fact was confessed, and it was also acknowledged, that they covered even lead-work with paintings and gilding, but no existing example could be adduced to give ocular demonstration on this point. Careful observation has at last revealed the existence of gilt, and painted stripes, zigzags or chevrons on the lead-work of turrets, and on that of the bases of hip-knobs, as well as instances of leaden ridges worked in fancy designs on their bottom edges.

Examples of the first kind of decoration exist at Rouen upon the turret of the Hôtel de Bourgtheroulde; upon another, above the foreportal of the library, belonging to the Archbishop's Palace, Rue S. Romain; and in an analogous position at the Maison Caradas, Rue de la Tuile. Upon the lead several chevrons are marked one above the other, which ought to be gilt, for only the traces of them are apparent.

Chevrons are still visible at the base of the hip-knobs, which accompany the little crest of the house Rue Bourg l'Abbé, Fig. 6, Plate 81, as also below the bases of the two crosses of S. Romain's tower at the cathedral, Fig. 5. The same chevrons are to be seen at Vernon upon the leadwork of a turret, and at the bell towers of the church of Notre Dame, Châlons-sur-Marne. The chevron indeed was a sort of ornamental type, to which artists were formerly addicted.

The lead covering of the ridges of roofs also received gilt designs, as seen upon the house No. 17, Rue Herbière, in the main building at the bottom of the court, built in the first half of the seventeenth century. This very rare and curious specimen, unique in Rouen, is shewn in Fig. 2. The crests of the abbatial buildings of S. Ouen, Fig. 8, of the parish church of S. Vincent, Fig. 1, and of the Château de Meillant, Fig. 9, testify to the use of this decoration of roofs.

Below the splendid crest at the old Louvre might be seen rich garlands produced upon the lead by the application of gilding, and probably also of painting. (Jacques Androuet Ducerceau, architect, 1576.)

M. Duban, the architect charged by government with the restoration of the Château de Blois, has recognized upon the lead-work of the roof of this ancient royal residence, traces of the devices and cyphers of Louis XII and of his wife Anne de Bretagne, of porcupines, of the letter L, of fleurs-de-lis, ermine spots, etc.

The lead of the roof of the church of Nôtre Dame at Châlons-sur-Marne, exhibits clearly, even now, the traces of different ornaments, and of a S. Sebastian, which are not worked in relief (as some persons have believed), but which have been painted and gilt, for everywhere time has made the gilding disappear. A cause for the opinion that this mode of once ornamenting the ridges was the result of embossing, is, that in the places where the metal has not been protected from the action of the air by gilding or painting, it has diminished in thickness from the effect of oxidation.

For the completion of the decoration of roofs, the exterior edges of the leaden ridge, which was dressed to the slates, were cut like a fringe; this ornamental cutting, then resembled a curtain or mantling (*lambrequin*); the example, Fig. 3, is taken from the house in the Faubourg d'Eauplet, No. 63, built about the year 1680. Two other examples at Rouen still exist; one in the Rue d'Elbœuf, No. 36, upon a house built in the latter half of the seventeenth century, the other upon a pavillion appearing to date from the minority of Louis XIV, and decorated with two remarkable hip-knobs, which stands upon the property, making the angle of the Rue des Grosses-pierres, Rue du Renard, 57 and 57 bis. At the Château of Versailles, on the side of the marble court, may be seen analogous work on the leaden ridge of the buildings, which belong to the era of Louis XIII; but this usage of the lead upon roofs was known at the appearance of the Renaissance; it was recognized upon an attentive examination of the Château de Meillant.

The ruling passion of our fathers for the decoration of roofs, and even for all sorts of ornaments, arrived at the point of masking by a fine grotesque head in lead, the eastern extremity of the ridge (wooden) of the house built at the end of the sixteenth century, Rue aux Ours, No. 87, formerly Rue S. André; it is seen over the adjoining house, which is lower.

Another example, a rain-water pipe striped yellow and blue, is to be seen in the court yard of a house called Agnes Sorel's, at Orleans, built under Louis XII, and Francis I.

Royal authority once wished to put a restriction on this luxury of external decoration, which it regarded as unbridled amongst the citizens; for a sumptuary ordinance, emanating from Charles IX in 1560, prohibited to town and country people the use of gilding on wood, lead, and iron on the exterior of their residences.

This popular propensity in France for decoration, or rather for the fine arts in general, dates from the epoch of the expeditions under Charles VIII and Louis XII into Italy,—the country, where a return towards the traditions of antiquity already existed.

It is not, perhaps, out of place to quote here a passage of a contemporary historian, who bears witness at the same time to the state of prosperity, which France then enjoyed. "Large edifices are built, both public and private, full of gilding, not only the timber work and internal walls, but the roofs, coverings, towers, and statues which are without; and so are the houses furnished with everything more sumptuously, than they ever were before."—SEYSSEL, *Histoire de Louis XII,* 4to. Paris. 1615.

The use of crests, and probably also of hip-knobs, traces back to a very remote period; for two religious edifices in the Department of the Puy-de-Dôme, belonging to the style of the 11th century, are still adorned with this species of ornamentation (which is seen on shrines, and is also shown in manuscripts). These are the church of Notre-Dame-du-Port, at Clermont in Auvergne, and that of Issoire. Both have, on the ridge of their principal naves and upon their transepts, a stone crest composed of circles interlaced like the links of a chain: for their structure and details the reader is referred to MALLAY-MOULINS (*Essai sur les Eglises Romanes du Département du Puy-de-Dôme*, fol., 1838).

A private house at Delft has a similar ornament on its ridge, between two hip-knobs, but it is made of lead.

The epoch, called the Renaissance of the Arts, from Louis XII to Henry III inclusive, saw the triumph of this sumptuous kind of decoration, which was then employed with profusion.

The crests were composed of pieces of timber, carved and covered with lead, fixed to the ridge of the buildings, or of wrought iron-work, either bare or also covered with lead; they were even made of stone, like those of the two churches of Clermont in Auvergne, which have just been described.

In general the crests, in the mass, composition, and distribution of their ideas, are imitations of the parapets bordering the high galleries of churches and other grand edifices.

Indeed, all the civil and religious edifices of any importance in the fifteenth and sixteenth centuries, and during great part of the seventeenth, were decorated with crests and hip-knobs, and the lead-work of their roof shone with gilding and painting.

Such were the Châteaux of Amboise, Anet, Blois, Chambord, Chenonceaux, Ecouen, Fontainebleau, Gaillon, le Louvre, Madrid (near Paris). Such were also the Hôtel-de-Ville at Paris, which preserved, till nearly the middle of the seventeenth century, a very elegant crest, composed of fleurs-de-lis and crescents alternately (see the engraving by Marot); the ancient chamber of the Comptes de Paris, with a crest until the fire in 1737; and the ancient Hôtel-de-Ville at Châlons-sur-Marne, which had a very highly ornamented crest.

Several of the French cathedrals had on their ridges running friezes, composed of fleurs-de-lis and trefoils alternately. These friezes or crests at Evreux cathedral were still more rich on the ridge of the choir, whose apse is surmounted by a statue of the archangel S. Michael trampling upon Satan. The roof of the church of S. Michael at Tonnerre was also surmounted by a very fine crest (see the view engraved by Israel Sylvestre).

As regards the town of Rouen, it is known that the choir of the cathedral was ornamented, for the whole length of its lead roof, by rich open-work, which was terminated by a S. George. This colossal equestrian statue was taken down in 1794 to convert it into musket balls. The same ornamentation existed at the chapel de la Vierge in the same metropolitan church, and at the Archiepiscopal Palace; the Abbatial Palace of S. Ouen, at Rouen, demolished about the year 1816, was also formerly surmounted by a crest, shown in Fig. 8, after an engraving which François Pommeraye gives of the building in his history of this Royal Abbey; also at the chamber of the Comptes de Normandie; at the Hôtel de Bourgtheroulde, etc.

The roof of the arcade of the Grosse Horloge was decorated with a crest, accompanied by two hip-knobs, one carrying the sun, the other the moon; and in the centre of the crest, another knob carried the arms of the town.

None of these crests are now remaining, and very few towns can flatter themselves, after the destructions which have occurred, with possessing like Rouen anything of the kind.

Thus may still be seen there, an iron open-work crest, Fig. 6, crowning the ridge of a house of the fifteenth century, at the corner of the Rue Royale, and of the Rue Bourg l'Abbé, which belonged to the monastery of S. Ouen.

The high-pitched slated roof of a stone building erected at the epoch of the Renaissance, and situated in the Cour de l'Albane, near the cathedral of which it was once the charter-house, is terminated by a crowning, probably truncated, which has the peculiarity of a little open balustrade made of wood and lead. Fig. 4.

The belfry, with a high rectangular roof, of S. Romain's tower in Rouen cathedral, built in the fifteenth century, presents between its two crosses a crest or dentelle, Fig. 5, of which examples may be found at Blangy (Seine-inférieure) and elsewhere.

The Palais de Justice, built in the reign of Louis XII, is (excepting the two houses just described, and the bell tower of S. Romain) the only building in Rouen now enriched with this elegant decoration and in one portion only; still it does not exist complete; it has wanted its crowning since the year 1794, and the restoration, Fig. 7, exhibits only an attempt to re-establish the design, preserving one of the intermediate pinnacles, which as well as the two great hip-knobs of the ends of the roof were all re-worked in the reign of Louis XIII.

A drawing, by an architect in the time of Francis I of a charming crest for the church of S. Vincent, at Rouen, has been found in the archives of the department, and, reduced to one half the size of the original, is given in Fig. 1.

In the department of the Cher the Château of Meillant crowned with its crest and hip-knobs offers a very rare example of the complete decoration of an ancient roof. M. Lenormand, charged with the restoration of the Château, supplied the drawing for Fig. 9. The building owner was named Chaumont; and in allusion to his name, a sort of rebus, Montchaud, was produced in the leaden ridge by gilding and painting hills and flames.

M. Duban, architect of the S. Chapelle de Paris, has taken from a building in the town of Bruges a crest of the year 1608.

At Abbeville, a little crest of the seventeenth century composed of foliage in lead, with two hip-knobs despoiled of their ornaments, decorates a pavilion at the bottom of a garden in the Rue Chasse-rats corner of the Rue d'Angouche.

An elegant, and at the same time a simple, crest was described as still existing at Tours in 1831, upon an ancient house with a steep roof.

The above may suffice as examples of crests now remaining on houses; and as to the churches there are very few which have preserved this ornament; the following may however be mentioned: the cathedral of Rheims, the church of S. Vulfran at Abbeville, that of Conches (Eure), the cathedrals of Amiens and Noyon. The trefoils, which formerly served as a finishing to the roofs of these last cathedrals, were mutilated at the time of the revolution in 1830, being taken for fleurs-de-lis.

It must be observed, however, that where potteries have existed, hip-knobs and crests in terra cotta have been made, and also ornamental ridge tiles. In the neighbourhood of Etampes have been found ridge tiles surmounted with a trefoil; and at Bayeux the author saw a little crest of the greatest simplicity, composed of small pieces of terra cotta cut to different shapes. By an exception almost unique, at Valognes and especially at Cherbourg, may be found ridge tiles crowning houses of the seventeenth century with open terminations, which affect gothic forms: these tiles so ornamented have continued, so to speak, to our own time. Ridge decorations are still seen upon the coverings of the buildings occupied by the potteries under Louis XIV and his successor at Rouen. They are in general vases with blue patterns on a white ground: of which very fair specimens exist upon the houses Rue du Faubourg S. Sever No. 101; Rue S. Julien No. 44, at the bottom of a court; and on the buildings of the pottery Rue Tous-vents No. 2 managed by M. Amedée Lambert. A white dove perfectly imitated in pottery rests upon a dormer window of No. 40, in the Rue d'Elbœuf.

Rouen, notwithstanding its incessant losses, is still the French town which affords the most various, the most numerous, and the finest examples of the ornamentation of the roofs of the fifteenth, sixteenth, and seventeenth centuries.

Out of France, a magnificent crest is to be seen on the immense cathedral of Cologne.

A. W. MORANT.

RIDGE.

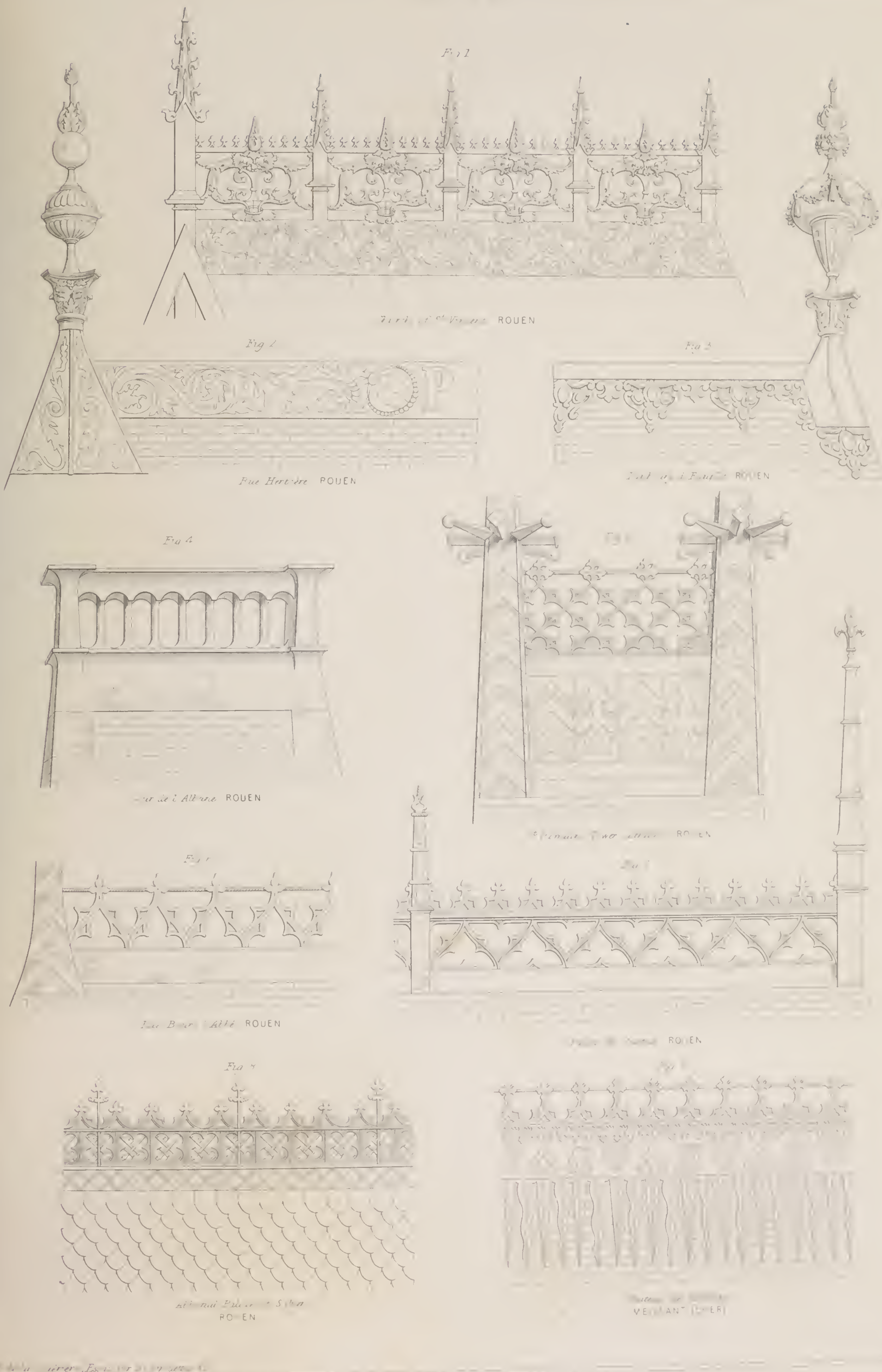


Fig. 1
ROUEN
Fig. 2
ROUEN
ROUEN
ROUEN
ROUEN
ROUEN
ROUEN
ROUEN
MEILLANT (CHER)

RORICZER

ON THE

CONSTRUCTION OF PINNACLES.

Roriczer, Roriser, or Rorizer, is the name of one of those families which in Germany, as well as in Italy, were devoted, during the middle ages, to the service of architecture, either from motives of religion, the rules of feudal superiors, the existence of guilds, the inheritence of accumulated precepts, or the difficulty of quitting the paternal roof.

Distinguishing individual members of the race, there remain (in the list of the architects employed upon the cathedral at Ratisbon) the Christian names of Thomas, who directed the construction of the church of S. Lawrence, at Nuremberg, and who was consulted upon the works of the cathedral of S. Stephen, at Vienna; of Konrad; and of Wolfgang, who was beheaded, with the sculptor Loy, for sedition. Popp and Buelau (*Les trois Ages de l'Arch. Goth.*, fol. Paris, 1841) also mention, at page 15, a work by Martin Roriczer, whom they term the last architect of the cathedral; but it seems almost certain that this name and title are the results of a mistake, and that the reference should have been to the *Treatise on the Ordination of Pinnacles and the Construction of Canopies*, by Mathes or Matthias Roriczer, wherein is contained all that is accessible of his history.

This production, for which he is inscribed amongst the masters of the art, is written in the dialect which was familiar to him, and of which the following quotation, from the description of his ninth figure, may serve for a specimen:—"**Darnach wen du dy vbrigen riss naher tust der man nit bedarf den nvr zu der ausztailung**" etc.

On the first page of the original is an escucheon, composed of the bearings of the family of Reichenaw, and of the diocese of Eichstedt, ornamented by the episcopal insignia, with the accompanying motto:—Wilhelmus episcopus Eustetensis ex familia Reichenaw natus hec imprimi fecit anno Dni mcccclxxxvi.

This imprint, it is observed by Boisserée (*Hist. etc. de la Cath. de Cologne*, 4to. Munich, 1843, p. 37 note), has become so rare, that at present copies of it are more generally found in old manuscripts than in type.

Notice of the great importance of the treatise was taken by F. Hoffstadt (*Gothischen A.B.C.*, preface, p. 8), who gave some quotations therefrom; and more recently it has been given to the world by C. Heideloff (*Die Bauhütte des Mittelalters in Deutschland*, Nuremberg, 1844). The whole appearance of this edition would lead to the supposition, that it was a fac-simile of the original impression; whereas, from the complaints of the latest editor, it would seem that the proof sheets had never been corrected.

The evidence on this point occupies too much space for insertion here, but is contained in the fifth page of the preface, by A. Reichensperger, to a translation of the original into modern German, by one of his friends (anonymous, but probably Linz, the publisher?). This version was the result of a laborious research made before the apppearance of Heideloff's book, and was seemingly lessened in value, on the re-publication of the original, so far as the point of scarcity was involved, but its greater practical utility was in no way depreciated.

Its especial worth arises from the circumstance of the want of supervision, above alluded to; and also (as will be proved by a glance at its predecessors) from the very important difficulties opposed by the antique and strange dialect, and by the frequent abbreviations, as well as by all the modes of expression, to those who are not accustomed to decipher such antiquities.

The title-page of this edition, consulted on the present occasion, reads thus:—" Das Büchlein von der Fialen Gerechtigkeit, von Mathias Roriczer, weyland Dombaumeister in Regensburg. Nach einem alten Drucke aus dem Jahre 1486 in die heutige Mundart uebertragen und durch Anmerkungen erlautert.—Nebst einem Anhange ueber die Construktion der Wimperge.—Mit einem Vorworte von A. Reichensperger. Mit 26 in den Text gedruckten Figuren. Trier, 1845."

It would be unjust to patron, author, and reader alike, not to preserve the following characteristic dedication, rendered with all possible fidelity, which stands on the second page of the original text.

" To the Right Reverend Prince and Lord, the Lord Wilhelm, Bishop of Eystedt, of the family of Reichenaw, my very good lord; do I, Mathes Roriczer, at present cathedral architect (Thumbmeister), at Regennspurg, signify my obedient humble service to the fore ready and willing:

" My very good Lord,—As your princely grace not only hitherto was, and now is, an amateur and patron of the free art of geometry, but also heretofore, even from the beginning in idea, wish, and resolution, has been a desirer that all those, who must make use, and obtain their support, of the said art, may advance in understanding thereof, so that the deficiencies and weaknesses (through which they do so assume a place to themselves in it, yet are not thoroughly well based) may become obviated, and that such an art of general utility should be thrown open and clearly exposed, so your grace at many times with me thereof has held discourse.

" To fulfil your grace's good pleasure, and to promote the common good (such indeed the materials of every art, shape, and size!), I have undertaken, with the help of God, to expound somewhat of the before-named art of geometry, and, from the very commencement of the drawn-out stonework, to explain how, and in what proportions, out of the very grounds of geometry with division by compasses, it ought to be deduced and brought into right sizes, and in the hereafter expressed manner, with a few illustrations, I have given it (and not altogether from myself is it elucidated, but, before all, especially from the old connoisseurs of the art, and particularly from 'the younkers of Prague'); begging your princely grace, and those versed in this art, to consider of this my performance, that I have undertaken it not for private glory, but altogether for general benefit, and where it is to be bettered, to better it, if any one will bring thereunto fruit, he will brighten up and give light to the art."

It being left uncertain by our author himself, as to what parts of the edifice at Ratisbon were placed under his supervision, there is little probability of this feature of his history being ascertained. Of this the difficulty has been above mentioned; nor is it certain that it will be removed by consulting the best authorities,—as GEMEINER'S *Chronicle* (Ratisbon, 1818?), or GUMPELSHEIMER'S *History* (Ratisbon, 1830). All that we know of the age of one of the finest cathedrals in Germany is, that it does not probably exhibit a higher antiquity than the early part of the fifteenth century. The famous Albertus Magnus was bishop until 1280, and in his time the third building was projected, to which a small portion on the left of the west entrance bears witness. Many dates are found in the cathedral, indicating the completion of detached portions. For example—on the eastern pillar is inscribed 1448; on the interior walling, near the chapel of S. Mary, 1464; above the principal angular entrance, 1482; and nearly parallel with this last, on the front of the northern tower of the west façade, is seen the date of 1486, at which period the edifice had attained its present form in the principal portions. From a wood-cut in G. ALT'S *Chronicle* (fol. Nuremberg, 1493), it appears that the towers were not even at that time so far finished as they now appear; they are represented, like that of Cologne Cathedral formerly, with a stone being raised, by means of a crane placed upon the summit of the most southern. In the text, the chronicler describes the edifice as then not complete. It also seems that an architect was employed in the year 1514; and that the vaulting was finished in 1618; the works ended in 1634.—POPP and BUELAU (p. 3).

It is therefore fortunate that the memory of our author's name has been ensured by the publication of his treatise, of which the before-mentioned third edition was noticed in the *Journal*, for 1847, of the ARCHÆOLOGICAL INSTITUTE OF GREAT BRITAIN (p. 21), but the too cursory mention, therein made, of the leading operations, renders it desirable that the architect should receive, as perfect as possible, the contents of—

THE PAMPHLET ON THE ORDINATION OF PINNACLES.

Passages between brackets are interpolations of the editor, unless otherwise assigned.

"Wouldst thou a plan draw for a pinnacle, after the mason's art, by regular geometry? then heave away", and—

I. On a given right line A B, describe a parallelogram ABCD, with the sides AB, BC, CD, and DA equal. [A square is meant, which also is the net size of the plinth of the shaft.]

II. Bisect the line AB in E, and also the lines BC in F, CD in G, and DA in H, and draw the lines EF, FG, GH, and HE. [Thence results another square, which is equal to the size of the shaft when worked, but see IV.]

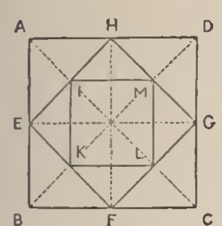


Fig. 1.

III. Bisect the line EF in K, and also the lines FG in L, GH in M, and HE in I, and draw the lines IK, KL, LM, and MI. [Thence results a third square, giving the faces of the panels of the shaft.]—See Fig. 1.

IV. Draw again a square equal to ABCD, with another therein contained, equal to IKLM, and similarly placed, and between them draw a square equal to EFGH, but turned round, "die kehr um" [*i. e.*, with its sides parallel to those of the other two squares.]—See Fig. 2.

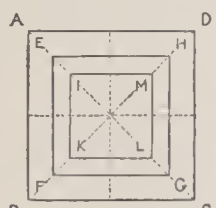


Fig. 2.

(The three squares in these specified proportions of Roriczer may be obtained in the right situations with respect to each other, and by simple geometric means, in the following manner:—In the constructed square, ABCD, inscribe a circle, in which, parallel with every side of the first square, construct a second square, which will be found equal to EFGH; in this, again, describe a circle, in which construct a third square, parallel to the sides of the before-constructed squares, and which will be found equal to IKLM.

It will be evident, at a glance, that the diagonal of the second square is equal to the side of the first; and, of course, that the diagonal of the third is equal to the side of the second; and further, of the largest circle taken as starting-point for the construction, that the side of the first square is equal to the diameter of this circle, or to double the tangent of the half right angle, or also to double the cotangent of the same angle—(for here tangent and cotangent are equal to each other)—the diagonal is equal to double the secant of the same angle in the same circle; the side of the second square is equal to double the sine (and also, because in an angle of 45°, the sine and cosine are equal, to double the cosine) of the same angle in the same circle; and further again, of course, that the side of the second square is equal to the diameter of the second circle, and so on with regard to the other relations already mentioned. One thus sees in what an intimate geometric relationship to each other the leading lines of our ground-plan stand.—REICHENSPERGER.)

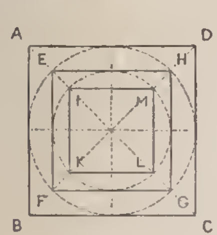


Fig. 3.

[The architect will observe that the circumscribed square is the square of the diameter, and therefore is twice the inscribed square, or four times the square of the radius; also that the diameter of the smaller circle represents the shaft of the pinnacle, and he will therefore, in practice, nearly reverse the operations of the last-mentioned construction, unless he should adopt the proportion of height.]—See Fig. 3.

V. On the diagram with the three squares, thus obtained, produce the line I K, to meet the lines E H and F G at N and N, and in the same manner produce the lines K L, L M, and M I.

VI. Divide the distance from I to N, by points, into three equal parts, and taking two of these points, with the centre N, and with the two-thirds of the line N I so divided, as a radius, cut off a distance N O, between N N on the line E H, and proceed in the same manner at each of the points N.

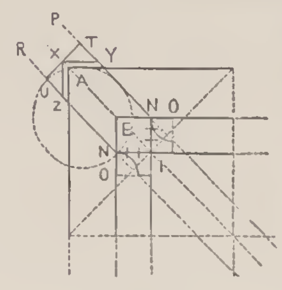


Fig. 4.

VII. Draw from each point O, a line perpendicular to the nearest side of the square I K L M, and joining it.

VIII. With the centre O, and the same radius O N, describe an arc of a circle at every point O, exactly so as to touch the points N, and the before-mentioned lines drawn perpendicularly from the points O to the square I K L M. [Thence results the hollow molding of the panel and the completed plan of the shaft.]

IX. On the diagram so far constructed, draw a line P Q [of indefinite length, parallel with a diagonal of the squares], through the point N, standing next to E in the line E H and the point N next to G in the line G H; also draw another such line R S [of indefinite length, parallel to the former line and to the same diagonal], through the points N standing next to E in the line E F and the point N next to G in the line G F: then proceed in a similar manner with lines parallel to the other diagonal of the squares, drawn through the other four points N N N N.

X. With a radius equal to the distance between the two parallel lines P Q and R S, draw a circle cutting off from the line N R a portion N U equal to twice the given radius; also, in the same manner, cut off from the line N P an equal portion N T, and draw the line T U: then proceed in a similar manner at the other corners of the great square.

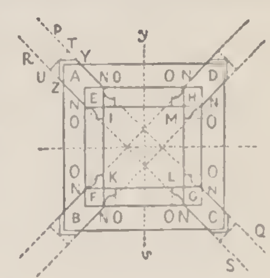


Fig. 5.

XI. Divide the line T U into two equal parts at X, and with the centre T and the radius T X cut off from the line T N a portion T Y equal to T X; and with the centre U and the radius U X cut off from the line U N a similar and equal portion U Z, and draw the lines X Y and X Z: then proceed in a similar manner at the other corners of the great square. [Thence results the plan of the crockets.]

So is the ground plan ready.—See Figs. 4 and 5.

XII. Bisect the line A D in *y*, and the line B C in *v*, and draw a line from *y* to *v*, by which line (since, in the elevation, when mention is made of it where discourse is held of the construction of the elevation, it is so termed) mark the words "centre line of the plan."

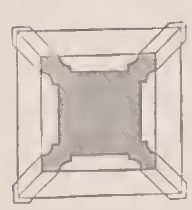


Fig. 6.

Thus is the ground plan for a pinnacle prepared: thereafter, when the letters and the construction-helpers (those only necessary to the division) are omitted from these lines, there is obtained such a diagram as the accompanying Fig. 6.

"Afterwards, wouldst thou the plan of the pinnacle updraw," [*i. e.*, from the ground plan of the pinnacle find the elevation],

XIII. Draw a right line *y v*, of indefinite length; this line, observe, is called the "centre line of the elevation" of the pinnacle; and thereon, with the width A B, equal to one side of the great square existing in the ground-plan already constructed, set off a length equal to six times the given width

A B, and mark the centre line at the division-points with the numerals 7, 1, 2, 3, 4, 5 and 6.

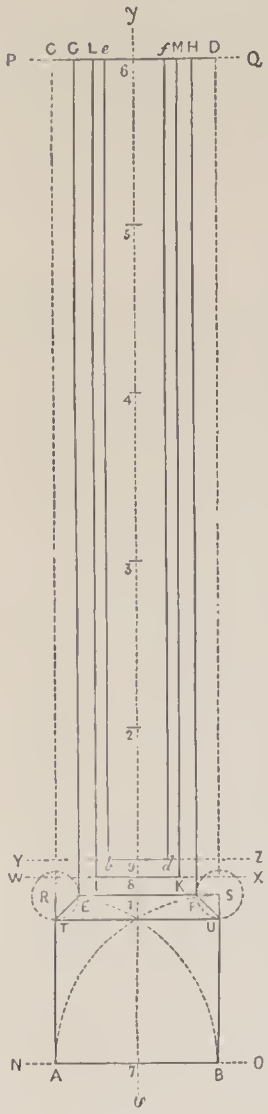


Fig. 7.

XIV. On the points 7 and 6 of the line *y v* draw right lines N O and P Q perpendicular to it, and produced indefinitely on both sides of it.

XV. With the centre 7, and with a radius equal to half the given line A B, cut off from the line N O equal portions 7 A and 7 B on each side of the centre 7; and with the same radius and the centre 6 cut off from the line P Q similar portions 6 C, 6 D, and draw the lines A C and B D.

XVI. With the centre A, and a radius equal to the given line A B, cut off from the line A C a portion A R; in a similar manner with the same radius and the centre B cut off from the line B D a similar portion B S, and draw the line R S, [Which will pass through the point 1 in the line *y v*, and will give the line of the bottom of the body of the shaft].

XVII. With the centre 1, and with a radius equal to half the line E F in the ground plan of the pillar, cut off from the line R S equal portions 1 E, 1 F on each side of the centre 1, and with the same radius and the centre 6 cut off from the line P Q, similar portions 6 G and 6 H, and draw the lines E G and F H [Which gives the elevation of the body of the shaft].

XVIII. With the centre R and the radius R E (equal to the distance between the lines A B and E F in the ground plan of the shaft) describe a circle cutting the line A C in T, and with the centre S and the same radius describe another circle cutting the line B D in U, and draw lines from T to U, and from E to T, and from F to U. [This gives the plinth.]

XIX. With the centre 1, and a radius equal to the distance between the lines E F and I K in the ground plan of the shaft, cut off from the line 1 *y*, a portion 1 8, and through the point 8 draw a line W X of indefinite length parallel to the line R S, then with the centre 8 and a radius equal to half the length of the line I K in the ground plan of the shaft, cut off from the line W X equal portions 8 I and 8 K on each side of the centre 8; and with the centre 6 and the same radius cut off from the line P Q equal portions 6 L and 6 M on each side of the centre 6, and draw the lines I L and K M. [This gives the margin of the panel moldings.]

XX. With the centre 8, and a radius equal to the distance between the lines E F and I K on the ground plan of the shaft, cut off from the line 8 *y* a portion 8 9, and through the point 9 draw a line of indefinite length Y Z parallel to the line W X; then with the centre 9, and a radius equal to half the width between the points O O in the line G H of the ground plan of the pillar, cut off from the line Y Z equal portions 9 *b* and 9 *d* on each side of the centre 9; and with the centre 6 and the same radius, cut off from the line M N equal portions 6 *e* and 6 *f* on each side of the centre 6, and draw the lines *b e* and *d f*. [This gives the size of the panel.]

Thereafter when the helping lines with the numerals and letters are omitted, there remains only that necessary to the pinnacle, which is called "the body of the pinnacle."—See Fig. 7.

Then wouldst thou make the pyramidal summit or spire upon the top of the body of the pinnacle;

XXI. Draw a right line *y v* of indefinite length, called the "centre line of the elevation of the spire," and thereon with the width A B of one side of the great square existing in the ground plan already constructed, set off a length equal to seven times the given width A B, and mark the line *y v* at the divisions with the numerals 8, 1, 2, 3, 4, 5, 6, 7.

XXII. On the points 8 and 7 of the line Y V, draw right lines I K and C D perpendicular to it, and produced indefinitely on both sides of it.

XXIII. With the centre 8 and a radius, equal to half the given line E F, in the ground plan of the pillar, cut off from the line I K equal portions 8 E and 8 F on each side of the centre 8, and with the centre 7 and a radius equal ("thou mayest also do well to make it moderately smaller"—) [It will be observed that in addition to the geometrical process a good judgment is necessary, but see the concluding remarks—], to the portion N O of the given line E F in the ground plan of the pillar, cut off from the line C D equal portions 7 N and 7 O on each side of the centre 7, and draw the lines E N and F O. This is hereafter called the "commencement of the spire or pyramidal summit to a pinnacle."

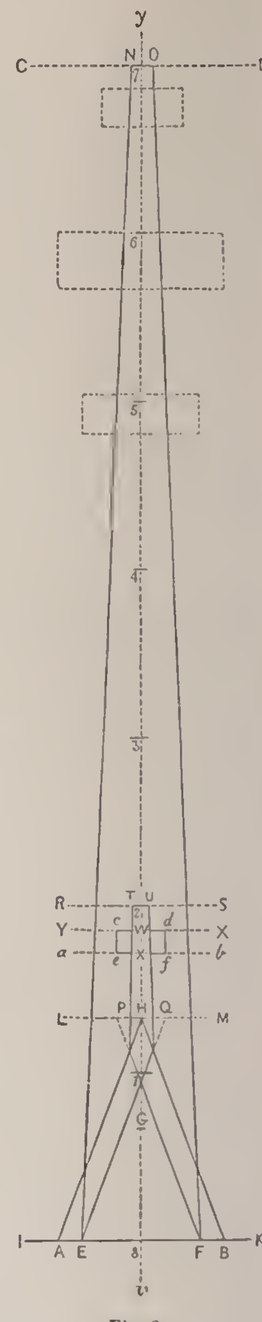


Fig. 8.

XXIV. Divide the line 8 2 into three equal parts 8 G, G H, and H 2; and with the centre 8 and a radius equal to half the given line A B in the ground plan of the pinnacle, cut off from the line I K equal portions 8 A and 8 B on each side of the centre 8, and draw the lines H A and H B. [Which gives the outline of the gablet.]

Through the point H draw a line L M perpendicular to the line *y v*, and produced indefinitely on each side of it; and with the centre H and a radius equal to the portion A E of the line I K, cut off from the line L M equal portions H P and H Q on each side of it, and draw the lines E Q and F P. [Which gives the thickness of the coping.]

XXV. Through the point 2 draw a line R S perpendicular to the line *y v*, and produced indefinitely on both sides of it, and with the centre 2 and a radius equal to half the length of the portion N O of the line E H in the ground plan of the pinnacle, cut off from the line R S equal portions 2 T and 2 U on each side of the centre 2: and from the point of intersection of the lines P F and H A draw a line to the point T, and from the point U draw a line to the point of intersection of the lines Q E and H B.

XXVI. With the centre 2 and a radius equal to the portion A E of the line I K, cut off from the line 2 8 a portion 2 W—and with the same radius and the centre W cut off from the line W H an equal portion W X: then through the points W and X draw right lines Y Z and *a b* perpendicular to the line *y v*, and produced indefinitely on both sides of it.

XXVII. With the centre W and the radius W X cut off from the line Y Z equal portions W *c* and W *d*, on each side of the centre W, and with the same radius and the centre X, cut off from the line *a b* equal portions X *e* and X *f* on each side of the centre X, and draw the lines *c e* and *d f*. [Which gives the finial on the gablet.]—See Fig. 8.

To draw the "flowers" to the spire of a pinnacle, proceed as follows, upon a diagram similarly constructed to the last.

XXVIII. With the centre 7 in the line *y v*, and with a radius equal to the given line A B in the ground-plan of the pinnacle, cut off a portion 7 C of the line 7 *v* [Which will be at the point 6, before obtained], and through this point C

draw a line D E perpendicular to the line *y v*, and produced indefinitely on each side of it.

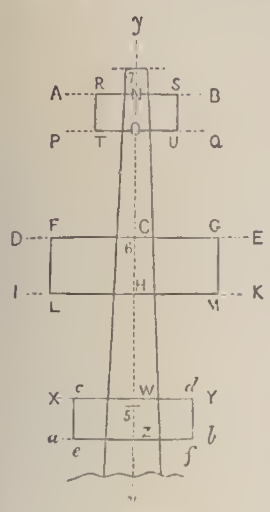


Fig. 9.

XXIX. With the centre C, and a radius equal to one-third [and not two-thirds, as in original, REICHENSPERGER] of the given line A B in the ground-plan of the pinnacle, cut off from the line C *v* a portion C H, and through the point H draw a line I K perpendicular to the line *y v*, and produced indefinitely on each side of it.

XXX. With the centre C, and a radius equal to half the length of the given line A B in the ground-plan of the pinnacle, cut off from the line D E equal portions C F and C G on each side of the centre C, and with the centre H, and the former radius C F or C G, cut off from the line I K equal portions H L and H M on each side of the centre H, and draw the lines F L and G M.

XXXI. With the centre 7, and a radius equal to the distance between the lines A B and E F in the ground plan of the pinnacle, cut off from the line 7 *v* a portion 7 N, and through the point N draw a line A B perpendicular to the line *y v*, and produced indefinitely on each side of it.

XXXII. With the centre N, and a radius equal to two-thirds of the line C H, cut off from the line N *v* a portion N O, and through the point O draw a line P Q perpendicular to the line *y v*, and produced indefinitely on each side of it.

XXXIII. With the centre N, and a radius equal to half the line I K in the ground plan of the pinnacle, cut off from the line A B equal portions N R and N S on each side of the centre N; and with the centre O and the same radius cut off from the line P Q equal portions O T and O U on each side of the centre O, and draw the lines R T and S U.

XXXIV. With the centre H, and with a radius equal to the line C O, cut off from the line H *v* a portion H W, and through the point W draw a line X Y perpendicular to the line *y v*, and produced indefinitely on each side of it.

XXXV. With the centre W, and a radius equal to the line N O, cut off from the line W *v* a portion W Z, and through the point Z draw a line *a b* perpendicular to the line *y v*, and produced indefinitely on each side of it.

XXXVI. With the centre W, and a radius equal to half the line E F in the ground-plan of the pinnacle, cut off from the line X Y equal portions W *c* and W *d* on each side of the centre W, and with the centre Z, and the same radius, cut off from the line *a b* equal portions Z *e* and Z *f* on each side of the centre Z, and draw the lines *c e* and *d f*.—See Fig. 9.

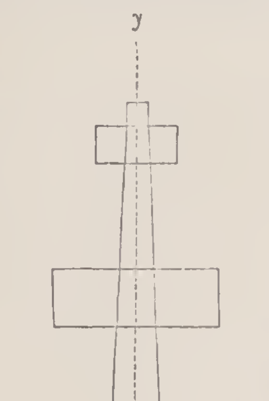


Fig. 10.

"Wouldst thou draw the bosses, or crockets (posen, the foliage on the angles), to the spire of the pinnacle from the plan," proceed as follows upon a diagram similarly constructed to the last, marked with the points A E 8 F B, in the line I K, and with the points *e f* in the line *a b*.

XXXVII. Divide the inclined vertical line included between the parallel lines I K and *a b*, and standing on the given point E, into six equal parts, E 1, 1 2, 2 3, 3 4, 4 5, and 5 6; and on the side I of the line E 6, and perpendicular to it, draw straight lines, 1 C, 2 D, 3 G, 4 H, and 5 L, and proceed similarly on the side K of the vertical line F 6 standing on the point F.

XXXVIII. With the centre 8, and a radius equal to half the distance between the points X X, on any one side of the square, A B C D, in the ground-plan of the pinnacle, cut off from the line I K equal portions 8 X on each side of the centre 8.

XXXIX. With the centre 6 and the radius E X cut off from the line *a b*, equal portions 6 *e* and 6 *f* on each side of the line *y v*, and draw the lines X *e* and X *f*.

XL. With a radius equal to the line T U in the ground-plan of the pinnacle, and with the centres E, 1, 2, 3, 4, 5 cut off from the line E 6, equal portions E M, 1 N, 2 O, 3 P, 4 Q, and 5 R; and with the same radius and the centres F, 1, etc., cut off from the line F 6, similar equal portions F M, 1 N, etc.; and through each of the points M, N, O, P, Q, and R, draw lines perpendicular to and between the parallel X *e*, E 6, and F 6, X *f*. [This gives the outline of the crockets.]—See Fig. 10.

Thereafter, if the spire be put on to the body of the pinnacle, and all letters, numerals, divisions, and construction-lines be left out, there will remain only the right lines necessary to the pinnacle; whereupon the figure will be called "a right pinnacle drawn out from the plan", as is seen in Fig. 22.

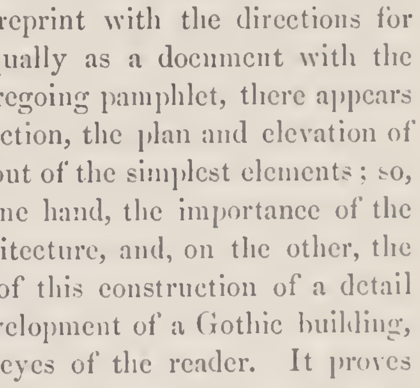
Thus has an end the "Treatise on the Ordination of Pinnacles", A.D. MCCCCLXXXVI, on the eve of Peter and Paul.

APPENDIX.

ON THE CONSTRUCTION OF A CANOPY.

(APART from the interest which it clearly in and of itself presents, the following construction, by some extraordinary accident mixed up in Heideloff's reprint with the directions for pinnacles, will be esteemed equally as a document with the above as a guide. As in the foregoing pamphlet, there appears how, through geometric construction, the plan and elevation of a pinnacle develope themselves out of the simplest elements; so, in the following notice, on the one hand, the importance of the pinnacle as a member of Architecture, and, on the other, the intimate and lively connection of this construction of a detail with the key to the general development of a Gothic building, will be put clearly before the eyes of the reader. It proves itself also, further, an art of the application of the octagon (formed through the overlaying diagonally of one square upon another), which in mediæval Architecture plays so great a part, and forms the starting point, especially in church building; for the construction of the chancel, as is well known, defines all the principal parts of the edifice.—REICHENSPERGER.)

"Wouldst thou make the templates (the molds to every part), and the flowers to a canopy, notice, that although some of the following illustrations are not drawn to the scale of the diagrams used in the treatise, yet, as will be seen on comparison, all the others in this Appendix are drawn in accordance with those before given, and of the same magnitude and scale, as all pinnacles of canopies are, of course, to be drawn in accordance with the principles already enunciated; so begin, and"



F. 11.

XLI. Make a square A B C D, equal to the given square A B C D, and therein inscribe a circle; through the centre Z whereof draw the diagonals and centre lines produced indefinitely.

XLII. With the centre Z, and a radius equal to the given line A B, describe a circle, and therein inscribe a square E F G H, parallel to the diagonals of the square A B C D. This gives the size of the hori-

zontal measurement of the four leaves of the great flower or finial of the canopy.]

XLIII. In the same circle inscribe a square I K L M of equal size to the last mentioned square, but parallel to the sides of the square A B C D, and let the line I M intersect the line H G in N, and the line H G intersect the line M L in O, and the line M L intersect the line G F in P, and the line G F intersect the line K L in Q.

XLIV. Bisect the line D M in R, and with the centre D and the radius D R describe a circle; and with the same radius describe a similar circle about the centre C.

XLV. With the centre G, and the same radius cut off from the line G Z, a portion, G T, and through the point T, draw a line V W, of indefinite length; and from the points O and P draw lines perpendicular to the line V W and joining it.

This gives the outline of the template for the arch moldings; for K Q will be the internal face of the wall, Q P the external splay, with one hollow moulding c therein; the rectangular parallelogram under P O will contain the jamb mouldings from which the template of the mullion is found, etc.—See Fig. 11.

[The jamb and hood mouldings are inserted as found in the original; for both of which, as they are not portions of *pinnacles*, no directions are given by Roriczer. On the present occasion it may not be useless to add, that it would seem the following would have been somewhat like his rule for them.

XLVI. Let the line H E intersect the line I K in X, and the line I K intersect the line E F in Y, and with the radius X Y and with the centres X and Y, describe on the side E arcs of circles intersecting on the indefinitely-produced line Z E in *a*; and with the same radius and with the centres X and *a*, describe similar arcs on the side X of the line *a* Z intersecting in the point *b*, and with the same radius and the centre *b* draw the arc X *a*.

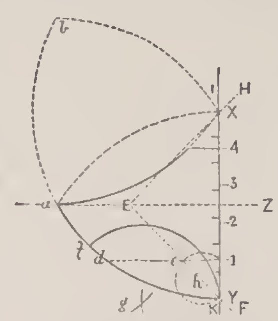


Fig. 12.
At twice the scale of plans.

XLVII. Divide the line X Y into five equal parts, X 1, 1 2, 2 3, 3 4, and 4 Y, and on the side E of the line X Y, through the point 1, draw a line perpendicular to X Y and cutting the line E Y in *e* and the arc Y *a* in *d*.

XLVIII. With the centre *a*, and a radius equal to the line *e* Y, cut off from the arc *a d* Y, a portion *a f*.

XLIX. With a radius equal to the line *d e*, and the centres *f* and Y, describe on the side *d* arcs of circles intersecting in the point *g*, and with the centre *g* and the same radius describe an arc between the points *f* and Y.

L. Lastly, perhaps, divide the line X Y into seven equal parts, and with the length of one of such parts as a radius, and the centre Y, cut off from the line *e* Y a portion *e h*, and with the centre *h* and the same radius describe a circle, whence the outline of the moulding may be traced.—See Fig. 12.

For the jamb moulding, the rule of the author may be presumed to have been as follows:—Let the line V W be intersected in the points *l* and *m*, by the lines perpendicular to it, drawn through the points O and P.

LI. Bisect the line O *l* in *n*, and the line P *m* in *p*, and draw a line produced indefinitely through the points *n* and *p*, and intersecting the line O G at the point *k*.

LII. Divide the line *m l* into eight equal parts, *m* 0, 0 5, 5 6, 6 T, T 7, 7 8, 8 9, and 9 *l*, and with a radius equal to one of those parts, and with the centre 5, describe an arc of a circle from the point 6 on to the line *n p*, and with the same radius, and with the centre 8, describe another arc from the point 7 on to the same line *n p*.

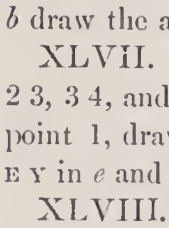


Fig. 13,
At twice the scale of plans.

LIII. With the centre T, and a radius equal to half the length of the line T 7, cut off from the line T Z a portion T *r*, and through the point *r*, draw a line on the side V of the line T Z, and perpendicular to it, joining the line 7 *k* in *s*, whence the outline O *k s r*, T 6 *p* P, may be traced; but all this is submitted with hesitation, especially as it may appear that the line T 6 should be longer by one-third, by moving the centre 5 so much the nearer to the point 0. The angle *s r* T forms the rebate for the glass.]—See Fig. 13.

"Wouldst thou find the geometric construction of a canopy, proceed in the following manner:—Upon any right line equal to the width thou wouldst give to the whole canopy:" [the architect will observe that this will be equal to the width between the centre lines of the pinnacles in the elevation, and also equal to the height of the shaft of the pinnacle, as drawn in Fig. 7.]

LIV. Divide the given right line, F G, into six equal parts, F A, A B, B C, C D, D E, and H G, and let A B be the length of one side of the largest square, A B C D, in Fig. 5. If the pinnacles

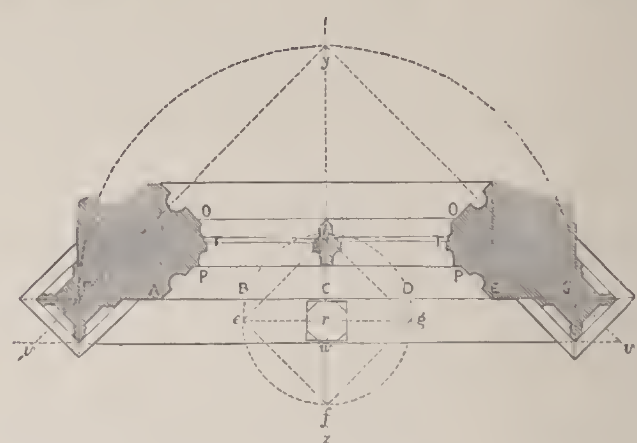


Fig. 14, at half the scale of plans.

be set obliquely to the front of the canopy, as here represented, Fig. 14, then

LV. Through the point C of bisection of the line F G, draw a line C *y*, perpendicular to the line F G, and equal to F C, and through the points F and G draw the lines *y v*, *y v*, produced indefinitely; these will be the centre lines, in which the points F and G will be the centres for the circles in the plan: if the pinnacles be set parallel with the front of the canopy, then the line F G, indefinitely produced, will be the centre line, but the points F and G will be the centres for the circle, in the plan as before.

LVI. Let the point F, and the line F A, represent the point K and the line K Q in Fig. 11, and thereon construct the diagram, Fig. 11, so far as is necessary to obtain the lines for the template K Q C P *p* 6 T *r s k* O D N I, and on the line G E repeat the operation in the contrary direction, and draw parallel lines joining the opposite points *p p*, 6 6, T T, *s s*, *k k*, and O O: [This gives the thickness of the wall and the mouldings of the opening.

LVII. (If necessary, as is here shown,) let the line *y z* represent a line in the direction of that marked with the letters O P, in Fig. 11, and on each side thereof draw the figure answering to the corresponding figure included between the parallel lines *p p* and O O. This gives the mullion.

LVIII. Let the line *y* C be produced of any indefinite length, *y z*, and with the centre C, and a radius equal to the distance between the point *a* and the point of intersection of the lines *a* Z and I K, Fig. 12, cut off from the line C *z* a portion C *w*, and through the point *w* draw a line parallel to the line F G, and indefinitely produced. This gives the place of the projection of the hood moulding, which must be stopped by corbel heads.]

LIX. (Bisect the line C *w* in *z*, and with the centre *w*, and a radius equal to the line Z E, in Fig. 11, describe a circle, and therein inscribe a square, *e f g h*, as in that figure. This gives the place for the plan of the four great leaves of the flower to the finial.—REICHENSPERGER.)

LX. [Supposing that the sides of the square *e f g h* be bisected, and from the points of bisection that lines be drawn forming a square which will be equal to the square A B C D, Fig. 1; if in this last-produced square two others are constructed, as in Fig. 1, then the smallest will be about one-thirtieth part less in the length of one of its sides than the projection of the hood moulding C *w*, and when reduced to an octagon, will give the plan of the stem of the finial at its base.]—See Fig. 14.

LXI. (But bisect the line *e f* in *i*, and also the lines *f g* in *k*, *g h* in *l*, and *h e* in *m*, and draw the lines *i k*, *k l*, *l m*, and *m i*; thence results another square, which is equal to the size of the moulding under the flower of the finial. (If this is to be an octagon, it must be so drawn, as shown by the dotted lines.)

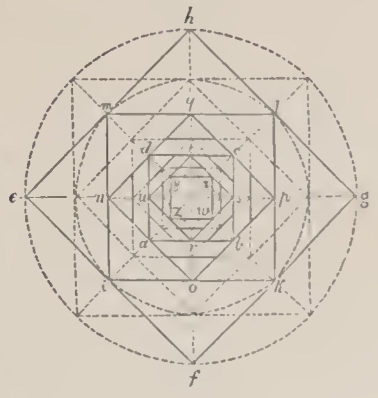


Fig 15.

LXII. Bisect the line *m i* in *n*, and also the lines *i k* in *o*, *k l* in *p*, and *l m* in *q*, and draw the lines *n o*, *o p*, *p q*, and *q n*; thence results another square, which, when reduced to an octagon, as shown by the dotted lines, is equal to the size of the plan of the pear-shaped knob of the finial.

LXIII. Bisect the line *n o* in *a*, and the lines *o p* in *b*, *p q* in *c*, and *q n* in *d*, and draw the lines *a b c d*; thence results a square, which, when reduced to an octagon, as shewn by the dotted lines, is equal to the size of the plan of the stem of the finial where it stands on the octagon moulding.—Reichensperger.)

LXIV. [Bisect the line *a b* in *r*, and the lines *b c* in *s*, *c d* in *t*, and *d e* in *v*, and draw the lines *r s*, *s t*, *t r*, and *v r*; thence results another square, which, when reduced to an octagon, as shewn by the dotted lines, was doubtlessly intended to be equal to the size of the plan of the stem of the finial when it stands on the large flower; but see further on.]

LXV. (Bisect the line *r s* in *w*, and the lines *s t* in *x*, *t v* in *y*, and *v r* in *z*, and draw the lines *w x*, *x y*, *y z*, and *z w*; thence results another square, which, when reduced to an octagon, as shewn by the dotted lines, is equal to the size of the top of the stem, in which the knob finishes.—Reichensperger.) See Fig. 15.

There remains to attain the mystery of the division of the heights of the parts of the stem, for which Roriczer only gives one rule, viz., that the stem of the finial of the canopy is to be equal to one-third part of the total height of the pinnacles. [And, it would appear, that one-third portion of the length of the stem is equal to the side of the square of the plan of the flower.

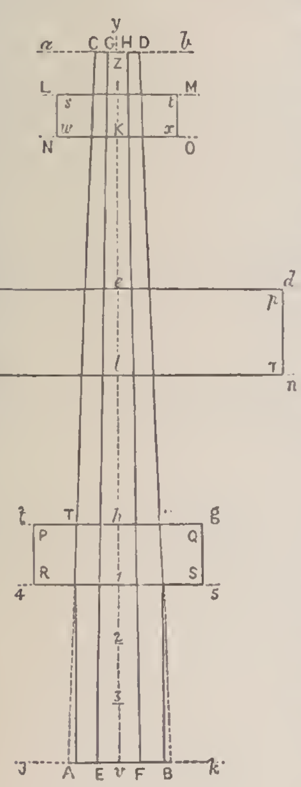


Fig. 16.

LXVI. Draw any right line *y v*, and thereon, with the centre *y* and a radius *y e* equal to the length of the line *e h* forming a side of the plan of the flower (Fig. 15.), divide it into three equal portions, *y e*, *e h*, and *h v*, and through the points *y*, *e*, *h*, and *v* draw lines *a b*, *c d*, *f g*, and *i k*, perpendicular to the line *y v*, and produced indefinitely on each side of it.

LXVII. With the centre *h* and a radius equal to half the length of the line *a b* in Fig. 15, cut off from the line *f g* equal portions *h* T and *h* U on each side of the centre *h*, and with the centre *y* and a radius equal to half the length of the line *w z* in Fig. 15. cut off from the line *a b* equal portions *y* C and *y* D on each side of the centre *y* and draw lines passing through the points T U, and joining the line *i k* in the points A and B.

LXVIII. With the centre *e* and a radius, *e l*, equal to the length of the line *a b* (*i.e.* to two-ninth parts of the line *e g* both) in Fig. 17, cut off from the line *e h*, a portion, *e l*, and through the point *l* draw a line *m n* perpendicular to the line *y v*, and produced indefinitely on each side of it.

LXIX. With the centre *e* and a radius equal to half the length of the line *e g* in Fig. 15, cut off from the line *c d* equal portions, *e o* and *e p*, on each side of the centre *e*; and with the same radius and the centre *l*, cut off from the line *m n* equal portions, *l q* and *l r* on each side of the centre *l*; and draw the lines *o q* and *p r*: this gives the size of the elevation of the flower.

LXX. With the centre *y* and a radius equal to the length of the line C D (or to one side of the square *w x y z* in fig. 15), cut off from the line *y v* a portion, *y* I, and, with the centre I and the same radius, cut off from the line I *v* a portion, I K, and through the points I and K draw lines L I M and N K O perpendicular to the line *y v* and indefinitely produced on each side of it.

LXXI. With the centre I and a radius equal to half the length of the line *n o* in Fig. 15, cut off from the line L M equal portions, I *s* and I *t*, on each side of the centre I; and, with the same radius and the centre K, cut off from the line N O equal portions, K *w* and K *x*, and draw the lines *s w* and *t x*: this gives the size of the elevation of the pear-shaped knob.

LXXII. Divide the length of the lines *h v* into four equal parts, *h* 1, 1 2, 2 3, and 3 *v*, and through the point 1 draw a line, 4 5, perpendicular to the line *y v*, produced indefinitely on each side of it.

LXXIII. With the centre *h* and a radius equal to half the length of the line *i k* in Fig. 15, cut off from the line *f g* equal portions, *h* P and *h* Q, on each side of the centre *h*; and, with the centre 1 and the same radius, cut off from the line 4 5 equal portions, 1 R and 1 S, and draw the lines P R and Q S: this gives the size of the elevation of the molding under the flower, of which molding the height is one-third part of the breadth. The lowest stem of the finial, as will be seen in the elevation of the canopy, is represented as perfectly uniform in thickness throughout, and must not be greater in size of plan than the square T U, if intended to stand on the projection of the hood mold; but as this is not likely to be generally the case in practice, the diagram shews a more elegant proportion, though the continuation of lines of the angle of 5° would be even preferable. T U is equal to the squares I K L M in Fig. 1, or *a b c d* in Fig. 15. —See Fig. 16.

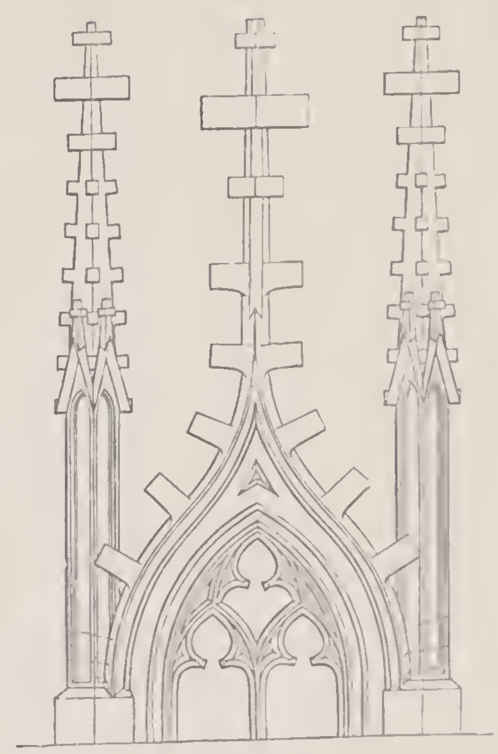


Fig. 17.

A: one third the scale of plans.

LXXIV. The remaining operation, namely, to render the octagon form to the ornaments, does not require any direction; and there then results the finished diagram for the finial, as seen in Fig. 17, with which the Appendix concludes.

OBSERVATIONS.

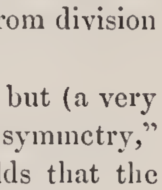
The value to be awarded to this work, and the amount of faith to be placed in its directions, may be fairly estimated by the standard of some very judicious remarks of the historian of Cologne cathedral, who says that all the forms and proportions *(shapes and sizes of Roriczer)* employed for that edifice, as well as the rules followed in the construction, are demonstrated to have resulted from the equilateral triangle and square, and their combinations with the circle, cross, and oblong rectangle.

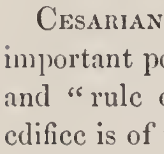
The plans of the cathedral church of Milan (as delivered to us by Cesare Cesariano, the first translator of *Vitruvius*, in his remarks upon that author, Como, 1521, fol. 14, 15) teach that that building was designed on proportions arising from division of the equilateral triangle.

Cesariano gives no explanation of the principle, but (a very important point for us) he does term it "Germanic symmetry," and "rule of the German architects," and he adds that the edifice is of the German sort. (Fol. 13, 15, and 2, fol. 65.)

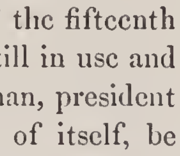
This testimony, given at the commencement of the fifteenth century, when the old church architecture was still in use and in all its vigour, this evidence of a very learned man, president over the construction of Milan cathedral, would, of itself, be proof, that this marvellous architectural style belongs especially to the Germans, and that it was the Germans who invented it, or at least brought it to the highest perfection. [A position well worthy of attention, though far from being generally allowed.]

Gaulth. H. Rivius, physician and mathematician, who published in German a translation of Cesariano (*Vitruvius Deutsch, etc.*, fol. Nuremberg, 1548, fol. 27) applies the term "principles of German stonemasons" (der Deutschen steinmetzen Grund), to what the other calls "Germanic symmetry." This denomination was doubtless then generally in use in Germany. In another passage of the same book, Rivius (fol. 27) names the order resulting from the *triangle*, "the highest and most distinguished principle of the stonemasons," and by that appears to refer to another and an inferior order.





And in fact there was another principle; but although the pointed arch was used in it equally as in the triangular system, the second principle rested altogether on the arrangement of the *square*, or rather of the octagon which proceeds from it, in the same way as the other law depending upon the management of the equilateral triangle was based upon the hexagon or dodecagon which resulted from it.



This law of the square, as it may be termed, is that on which the work of Roriczer is founded, and presents evident traces of the octagonal principle throughout.

The square, or octagon system, maintained itself amongst the German stonemasons until the commencement of this nineteenth century. At least the masons of Nuremberg were obliged, in order to obtain their freedom (*maîtrise*) to set out the plan of a church on the principle of the octagon (which in the old language was called "acht-ort" and "acht-uhr", *i. e.*, eight pointed) and this custom lasted till 1806, the period at which this imperial city lost, with its independence, its ancient constitution, and its institutions of tribes or guilds (*tribus*). Boisserée adds, "I owe all this information to a worthy man, Master Laurent Kieskalt, last city architect of Nuremberg, who gave me a copy and an explanation of his master-piece. Hereafter, in an examination of the system of ancient church architecture, I hope to be able to give a more detailed account of this chef-d'œuvre." It is in the note to this passage that he mentions the scarcity of Roriczer's treatise, classing it, as containing rules essentially the same with those followed by Kieskalt, with those in the book of instructions written in 1506 by Lorenz Locher, architect of the Count Palatine, on the art of the stone-mason, "nach des Chores maass und Gerichtigkeit," according to the measure and ordination of the choir. In the same category, he states, are also the rules mentioned by Stieglitz (*Ueber die altdeutsche Baukunst*, p. 240, etc.), as found by him in a manuscript of no greater antiquity than the middle of the seventeenth century, but which according to the formal assertion of the anonymous author, contains laws transmitted from the most ancient times. [This work refers to the design of church plans and elevations.] The difference between the older instructions and the chef-d'œuvre of Nuremberg consists, as might be expected, in that the written documents teach the principles in a more extended and more varied application.

Boisserée continues by urging that the more the student penetrates in the analysis of the proportions, the more he will be convinced that the fundamental principles of ancient church architecture are to be found, 1°, in the equilateral triangle, adopted first of all by the Pythagoreans as a symbol of Minerva or Wisdom. (F. Creuzer, *Symbolik und Mythologie 2te Ausgabe*, 11 Thl. p. 651-706, 8vo. Leipzig and Darmstadt, 1819-21. "Also the Pythagoreans have highly honoured the numbers and figures geometrical by the Gods' names; for the triangle with three equal sides they called Pallas born out of Jupiter's brain, and Tritogeneia for that it is equally divided with three right lines from three angles drawn by the plomb," Plutarch, *de Iside et Osiride*; and afterwards by our ancestors as a symbol of the Trinity; 2°. in the dodecagon resulting from the application of this triangle to the circle; a combination which the ancients, as well as their descendants (Vitruvius, lib. v. c. 6, compare lib. i. c. 1. Pliny, *Hist. Nat.* lib. ii, c. 22. Cesariano. *Vitruvio trad. et com.* fol. 10, 11, and 76. Philander. *Vitruv. comm.* 4to. Lugd. 1586, p. 21) regarded as containing all musical and astronomical proportion. (*Hist. etc. de la Cath. de Cologne*, p. 36, 37.)

[The Egyptian architects used squares in tracing the outlines of their designs. (Wilkinson, *Ancient Egyptians*, vol. iii. p. 313.)

By the Greeks the square was termed "the root of the eternally flowing nature" (Philolaus, *des Pythagoreers Lehren nebst den Bruchstucken seines Werkes*, Berlin, 1819), and was much employed in the designing of their edifices; Vitruvius (lib. v. c. 8) has described its use in forming theatres, and mentions that its sequent, the *octagon*, was employed in the formation of cities, as affording shelter from the various gales; at Athens the well-known "Tower of the Winds" was based upon it.

The Romans employed mostly the equilateral triangle. Its application to theatres is given by the same author as cited above; and to temples by Inigo Jones (in his work on Stonehenge, 1655).

The equilateral triangle was the figure whereby the ancients expressed what appertained to Heaven and divine mysteries also. "The Magi," says Pierius Valerianus (lib. xxix.) "add that a triangle of equal sides is a symbol of divinity, or sign of celestial matters."

The mediæval architects derived the equilateral triangle from Rome. The symbolism which it and its multiples had already acquired rendered it peculiarly acceptable to the clergy for the service of religion. The division of a circle by a triangle, a square, and a hexagon, seems to have been with geometricians an usual method of measuring. (Philander, *Vitr. Com.* lib. ix, c. 4.)]

It would seem that the great object of indecision of the older mediæval architects was the form most fitting and convenient to be given to the sanctuary or apsis of their basilicas; they wanted a certain rule; and geometry, united to their practised glance and the investigation of Nature, opened to them the right or good way: the equilateral triangle and the square became the key of their new constructive doctrine, and the former was their "unité." (Popp and Buelau, *les Trois Ages de l'Architecture Gothique*, Paris, l. f. 1841, p. 9.)

With regard to the proportions of the spire to the pinnacle in Roriczer's work, it is interesting to remember what Boisserée has observed, upon what he calls the "pyramidal system of Cologne Cathedral", based upon the equilateral triangle. The pointed arch constructed upon this triangle makes the most obtuse vertical angle in all the edifice; viz., of sixty degrees. Then comes the gable of the great roof between the two towers, with an angle of 51° 30; then the gable below it, which crowns the large window, with an angle of 47°; and lastly, the gable of the great roofs of the choir, and consequently of the transepts, with an angle of 49°.

All the gables of the upper windows of the choir have an angle of 45°, and those of the windows of the tower an angle of 40°. The remaining gablets of the buttresses, counterforts, and turreted pinnacles, have angles of 38°, 36°, 35°, 32°, and 30°, so that all, with slight deviations, are in the same relation as the central angles of the hexagon [60°], of the heptagon [51°, $25\frac{3}{7}$], of the octagon [45°], of the nonagon [40°], of the decagon [36°], of the hendecagon [32°, $43\frac{7}{11}$], and of the dodecagon [30°]. The spires of the principal towers form an angle of 15°, and those of many pinnacles on the buttresses and counterforts are the same. The spires of the little pinnacles are, for the greater part, of 10°, and those of the smallest of 5°, so that all these spires have between them the same relation which exists between, and are the same as, the central angle of polygons of twenty-four, thirty-six, or seventy-two sides.—*Hist.* etc., p. 72.

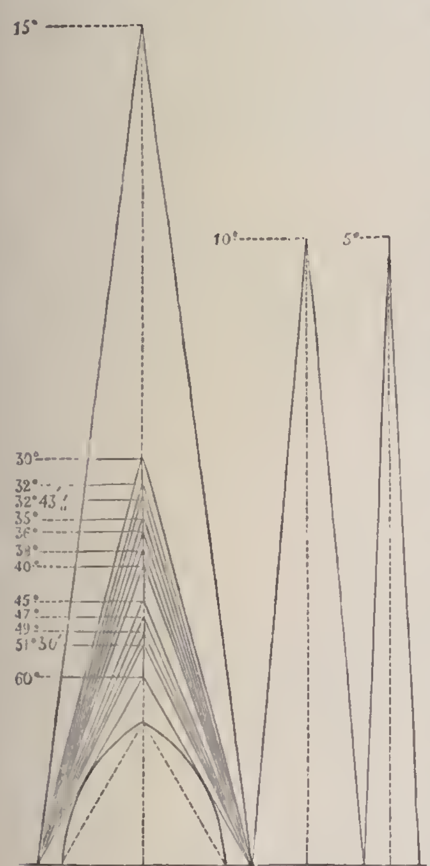


Fig. 21.

[The philosophical principle of the design of this shaft and spire in one pinnacle seems to be conveyed in the argument, that it can be drawn in the central angle of a seventy-two-sided figure—*i.e.*, in an angle of 5°,—which appears to be the case; for, having the plan of the pinnacle drawn as in Fig. 6, and circumscribed by a circle inscribed within a square, let one side of this square be the base of an isosceles triangle whose angle, included between the equal sides in 5°, and bisect that angle by a line produced indefinitely, which will be the centre line of the pinnacle required, and on which fourteen consecutive divisions, each equal to the given line A B in Fig. 1—*i.e.*, to the width of the shaft of the pinnacle—are to be marked off, giving points through which lines perpendicular to the centre line are to be drawn indefinitely produced, when, on following Roriczer's directions, it will be found that the first line marks the ground-line adopted by the master; the second, the top of the plinth; the seventh, the division between the shaft and the spire; the eighth, the gablet of the shaft; the ninth, the top of the finial thereon; the thirteenth, the top of the great flower of the finial; the fourteenth, the point at which the distance between the limbs of the angle of 5° will be, as recommended by Roriczer, moderately less than—*i.e.*, three quarters of—the length of the line N O in Fig. 8, which, if not reduced, would be included at about halfway between the thirteenth and fourteenth division; but this is altered, as its adoption would prevent almost all the geometrical incidents of adaptation, both in the spire of the pinnacle and in the finial of the canopy, and would spoil the relationship of the proportions which were found to exist (and very remarkably that of one ninth part of the total height) on making the distance between the centres of the pinnacles precisely equal to half the total height from the springing of the arch.

Beyond this and the adoption of the general law of design, "the smaller the real size of the base, the taller the actual height of the work," the authors of the preceding directions do not appear to have paid particular attention to effect in execution; nor was it necessary, since a difference of one degree and a half, almost inappreciable by the general eye, is the maximum variation of the angle of the spire in perspective.

The height of the triangle above the seventh division will be found, in practice, about eleven times and a half its base on that line.

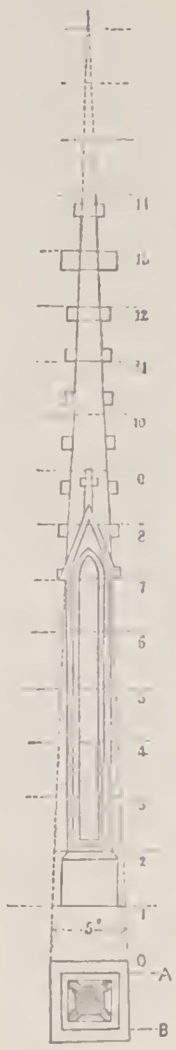


Fig. 22.

Even if Roriczer had intended to prescribe a form, and fix the proportions for *all* pinnacles, the value of his work would still consist in showing how he was guided in detailing *one* specimen; by laws generally taught and obeyed in his time, but which, being only the results of practical geometry, are not often, if ever, studied at this period, when that art "of universal use" is so much neglected by the student, for whom, by the preservation of Roriczer's *Treatise*, some of the rules are recovered.

But must they be taken as an invariable formula? or do such laws become susceptible of application in different manners, when an idea has been fixed, the key resolved upon, and the work furthered to the point of consideration of the details? Especially do the proportions of the shaft and the spire to each other, and in themselves, vary according to the spirit (*i. e.*, genius or taste) of the designer; a position supported by the old proverb of the masons—

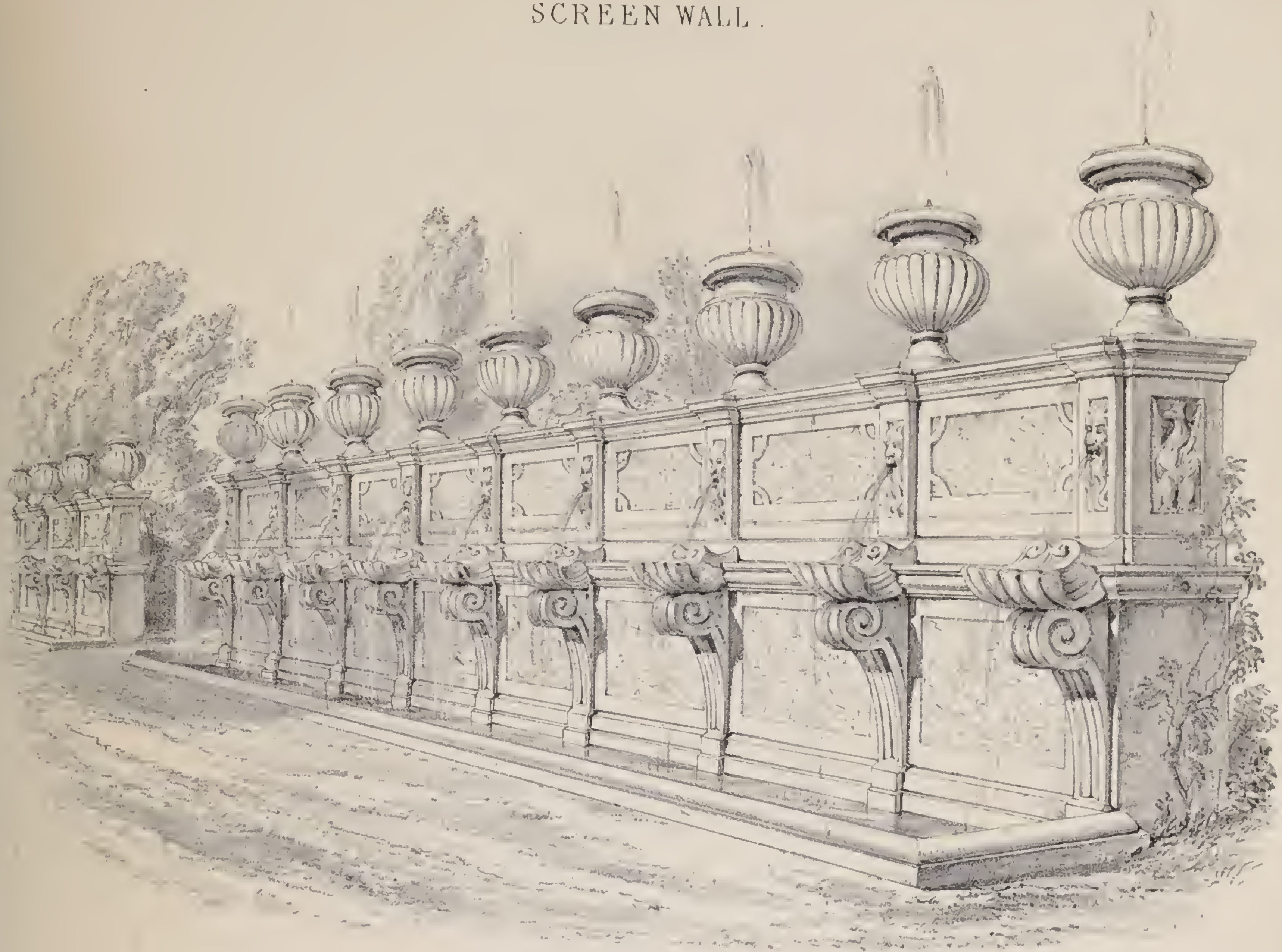
> "Zirkel's Kunst und Gerichtigkeit
> *Ohn Gott* niemand uslait,"

which may be translated—

> "That the Compasses' Theory and Practice
> *Without God*, profit nobody, a fact is."

John W. Papworth.

SCREEN WALL.



ROME.
VILLA DORIA PAMFILI.

Charles Fowler, Junr

Via del Corso.

ROME.
PALAZZO DORIA.

T H Lewis, M I B A

Lithographed by Messrs Day & Son, Jany 28th 1850

STAINED GLASS

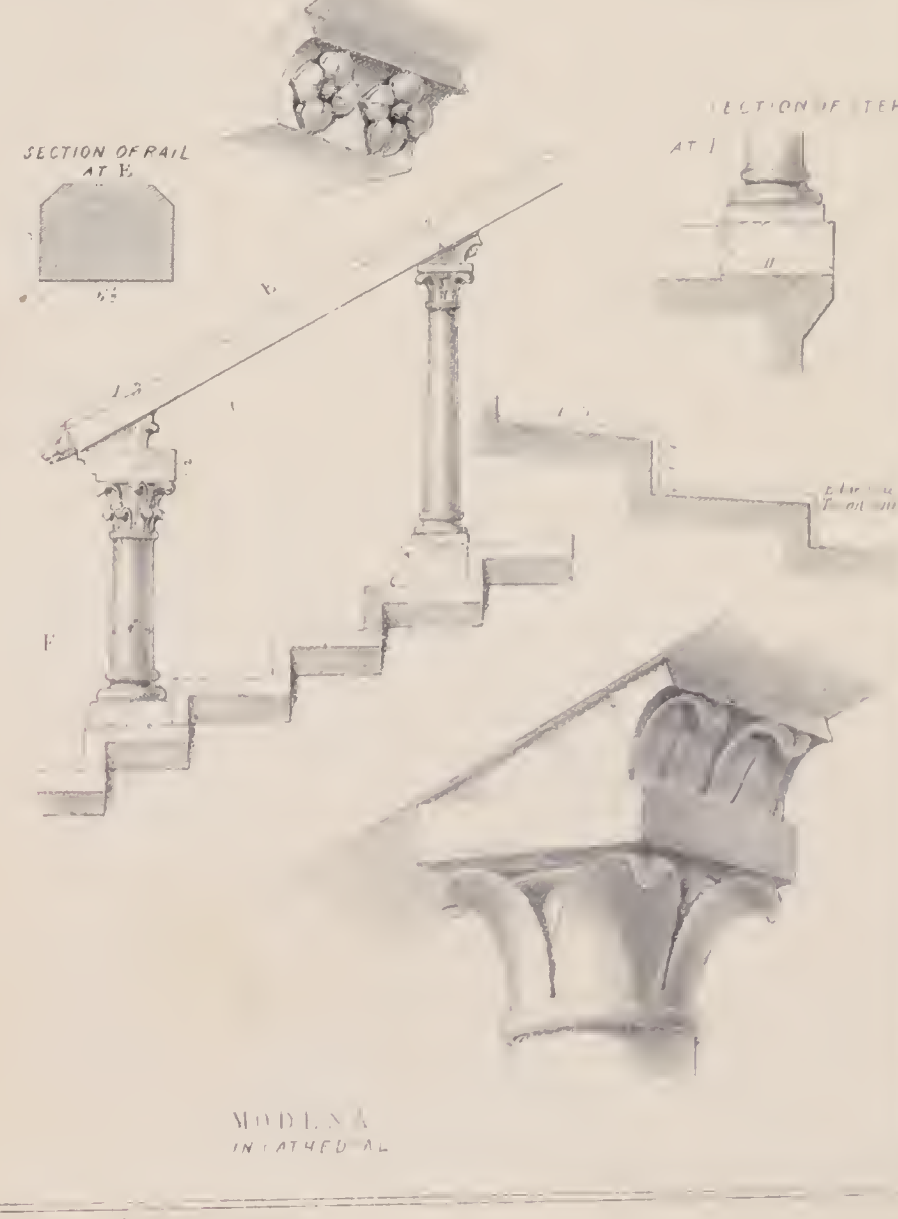
UPPER CHURCH OF SAN [illegible]
(EXECUTED BY FRA FRANCESCO D ERRANOVA [illegible] 470 [illegible])

[illegible]

STAIRCASE

IN CORTILE CASTLE of BRACCIANO NEAR ROME

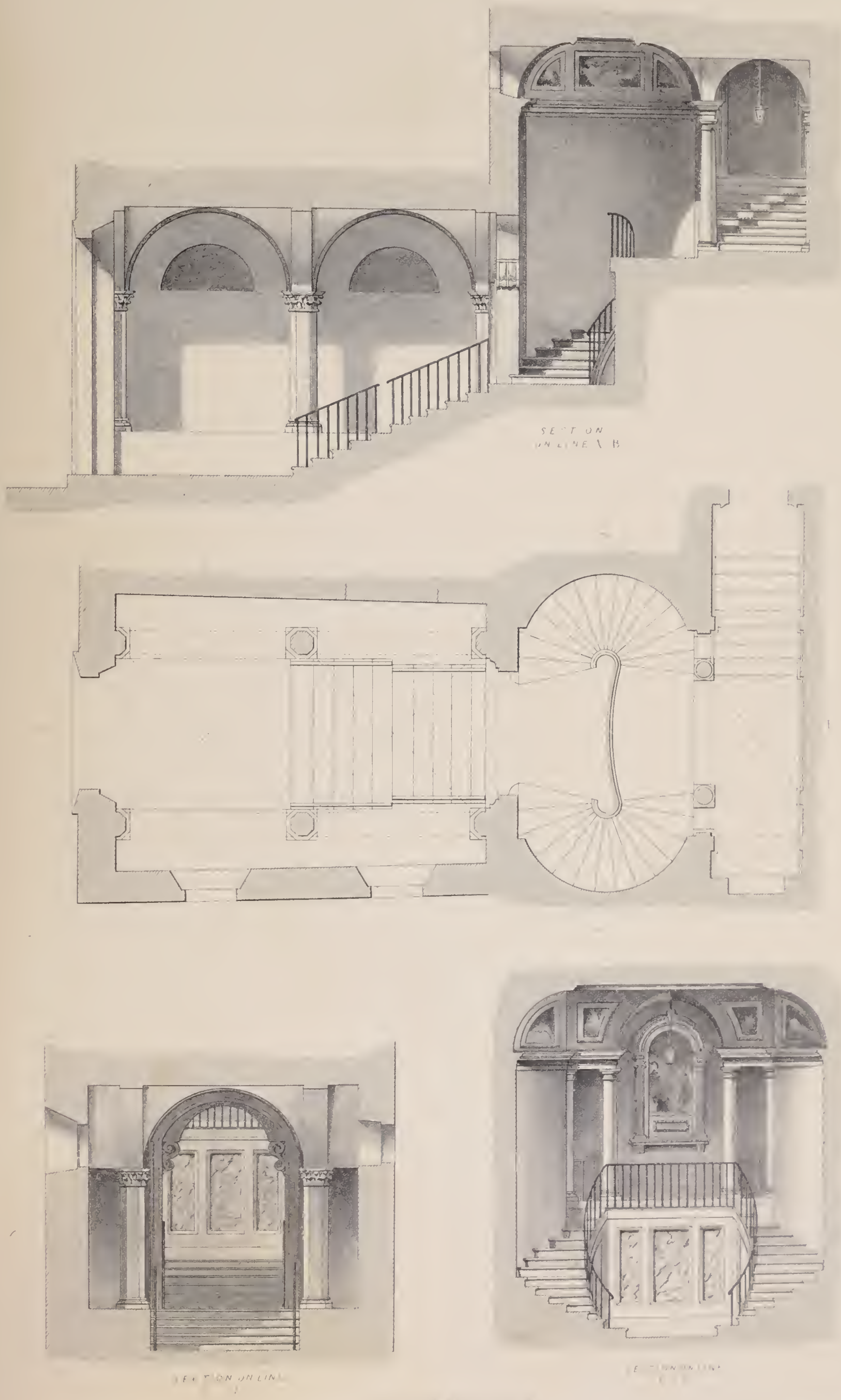
BUILT BY THE ORSINI 14



ASSISI.
CHURCH OF SAN FRANCESCO.

MODENA
IN CATHEDRAL

STAIRCASE

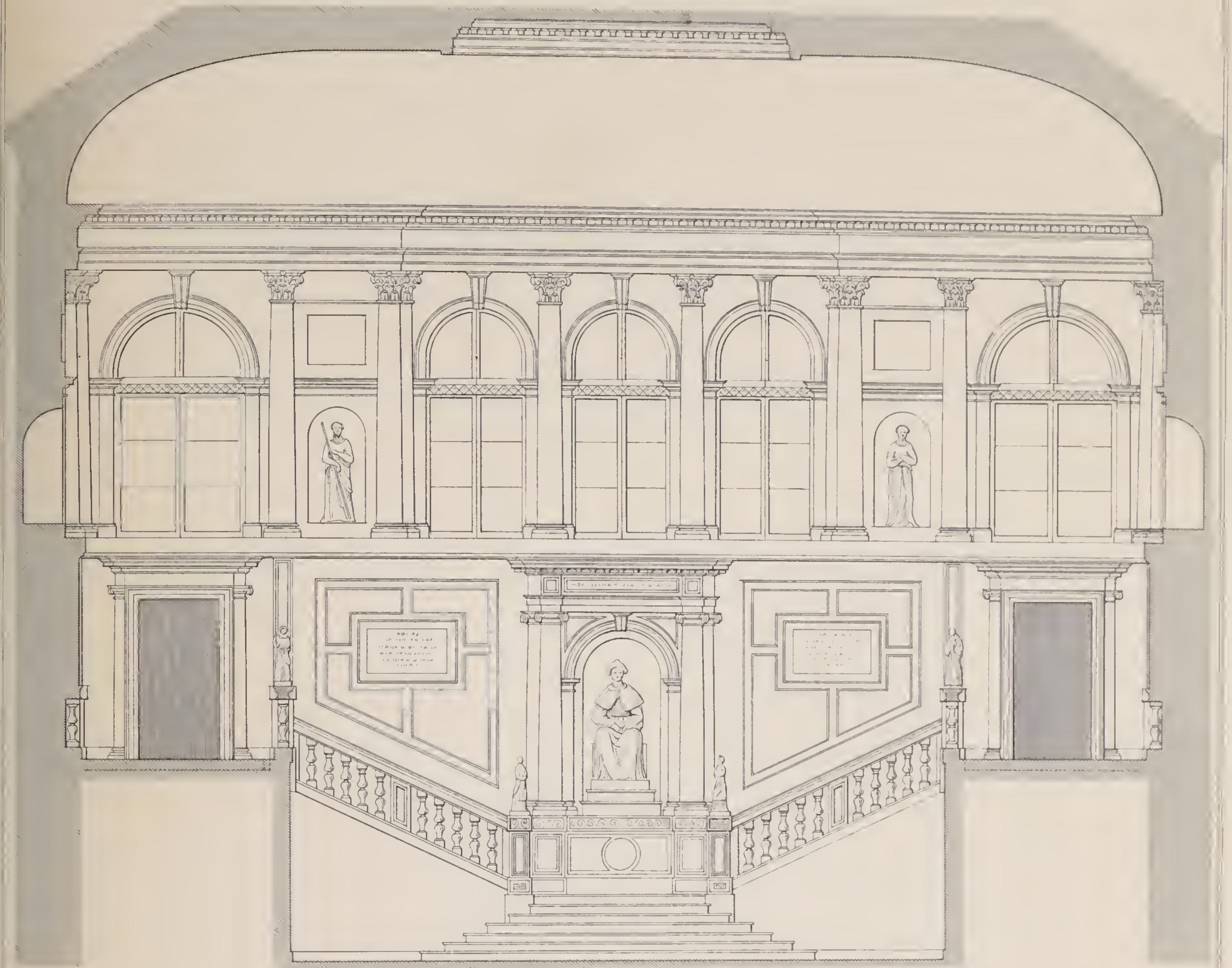


SECTION ON LINE

SECTION ON LINE

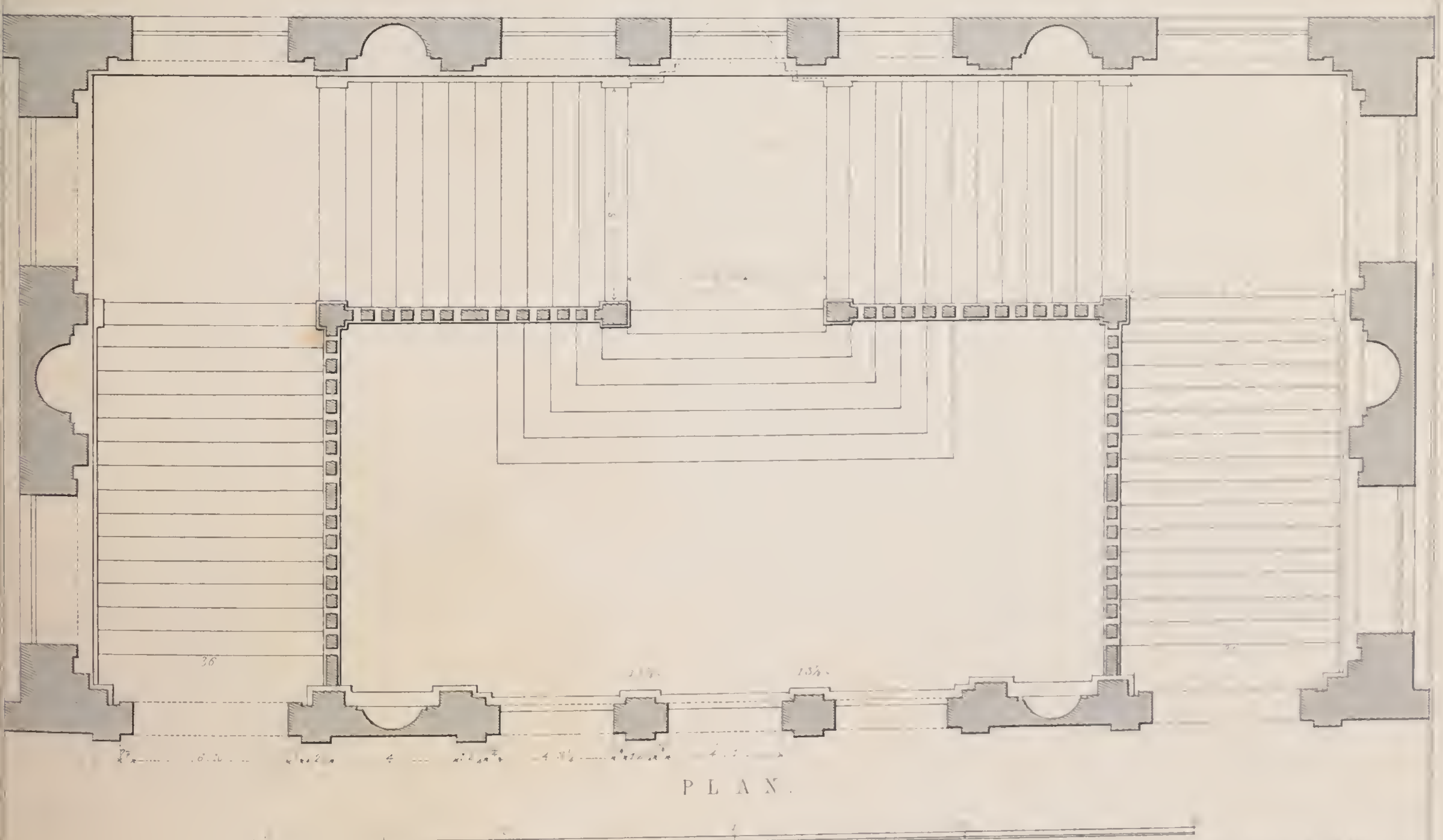
BERNINI ARCHT

STAIRCASE



SECTION.

MONASTERY ADJOINING THE CHURCH OF SAN GEORGIO, VENICE.



PLAN.

STAIRCASE.

Fig 1

GENOA

Fig. 2

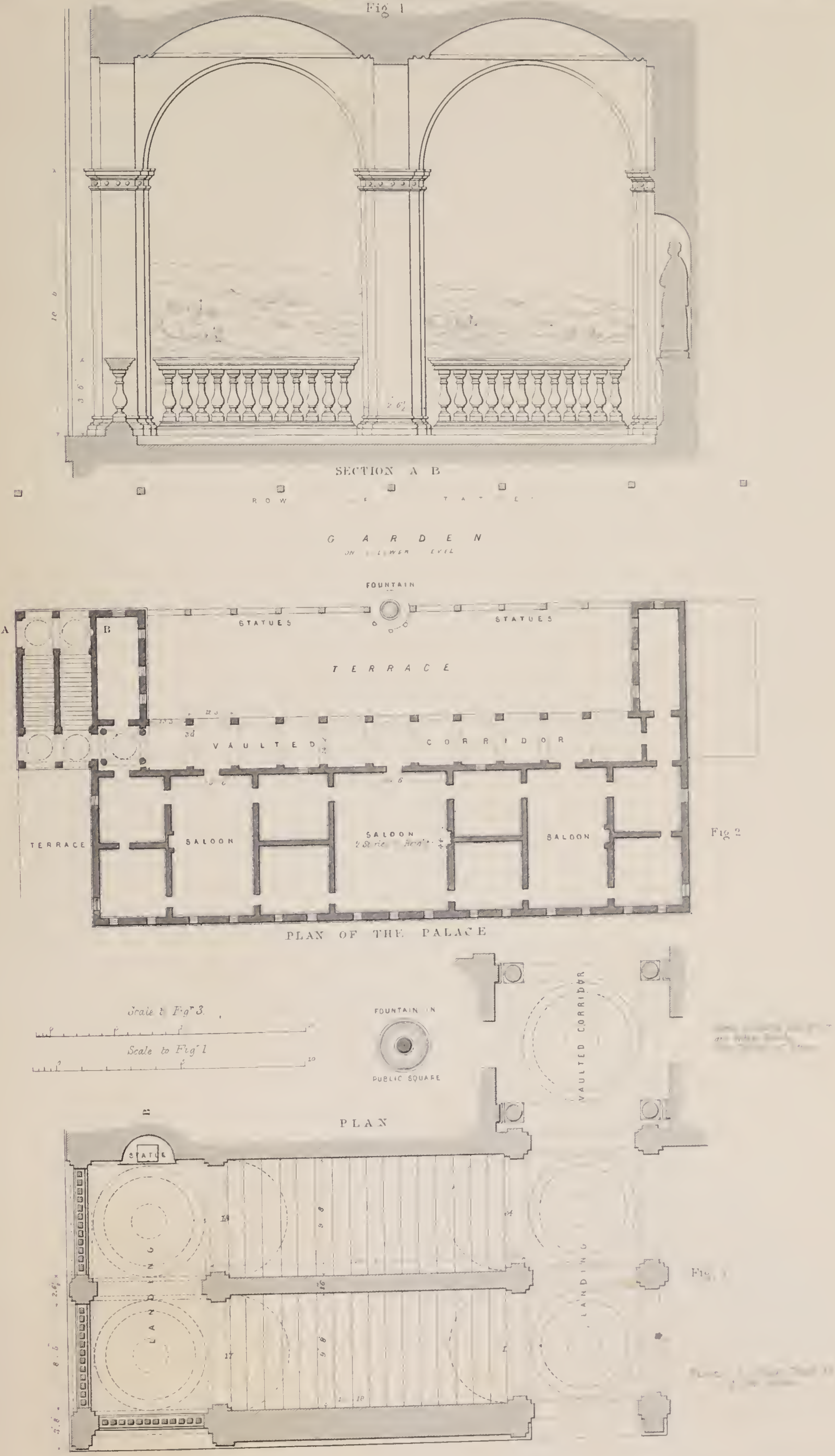
MUSEUM, ANGERS

James Bell M.I.B.A.

Lithographed by Messrs Day & Son, Lithrs to the Queen

STAIRCASE

Fig 1

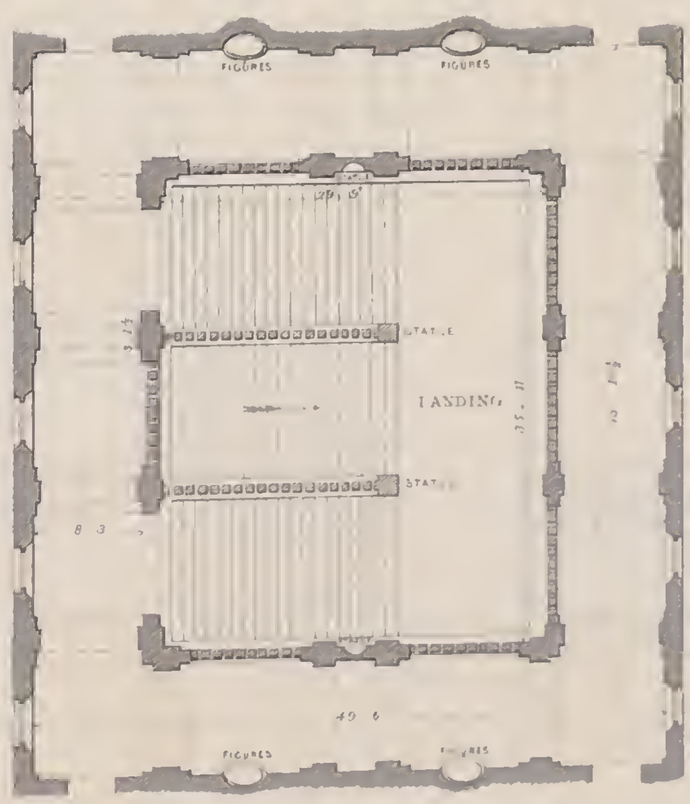


PALAZZO LANCELLOTTI VELLETRI

Meas.d in June 1847.

STAIRCASE.

SECTION ON LINE A B



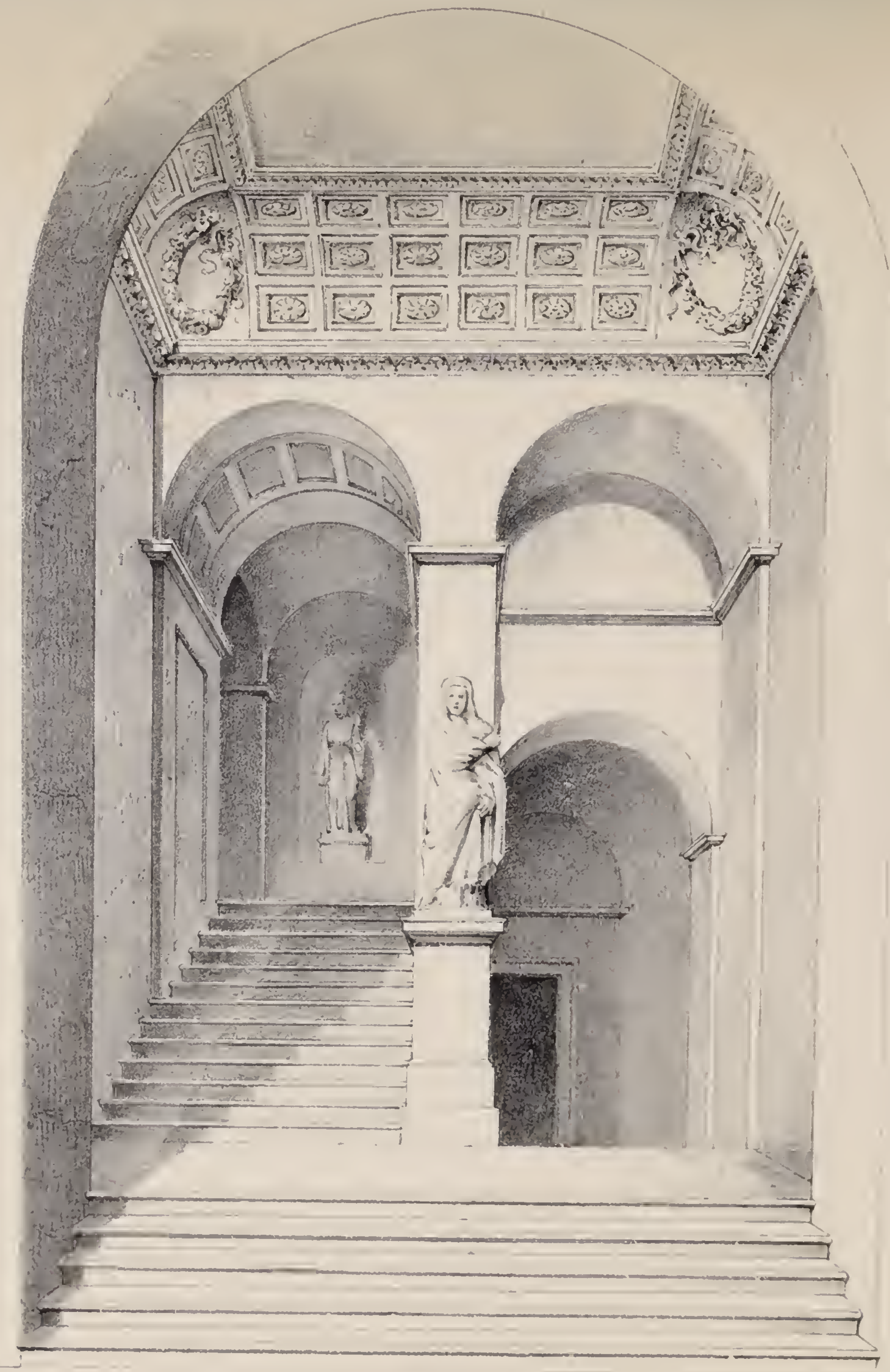
PLAN

F UPPER FL R

PALAZZO ERCOLANI,
BOLOGNA.

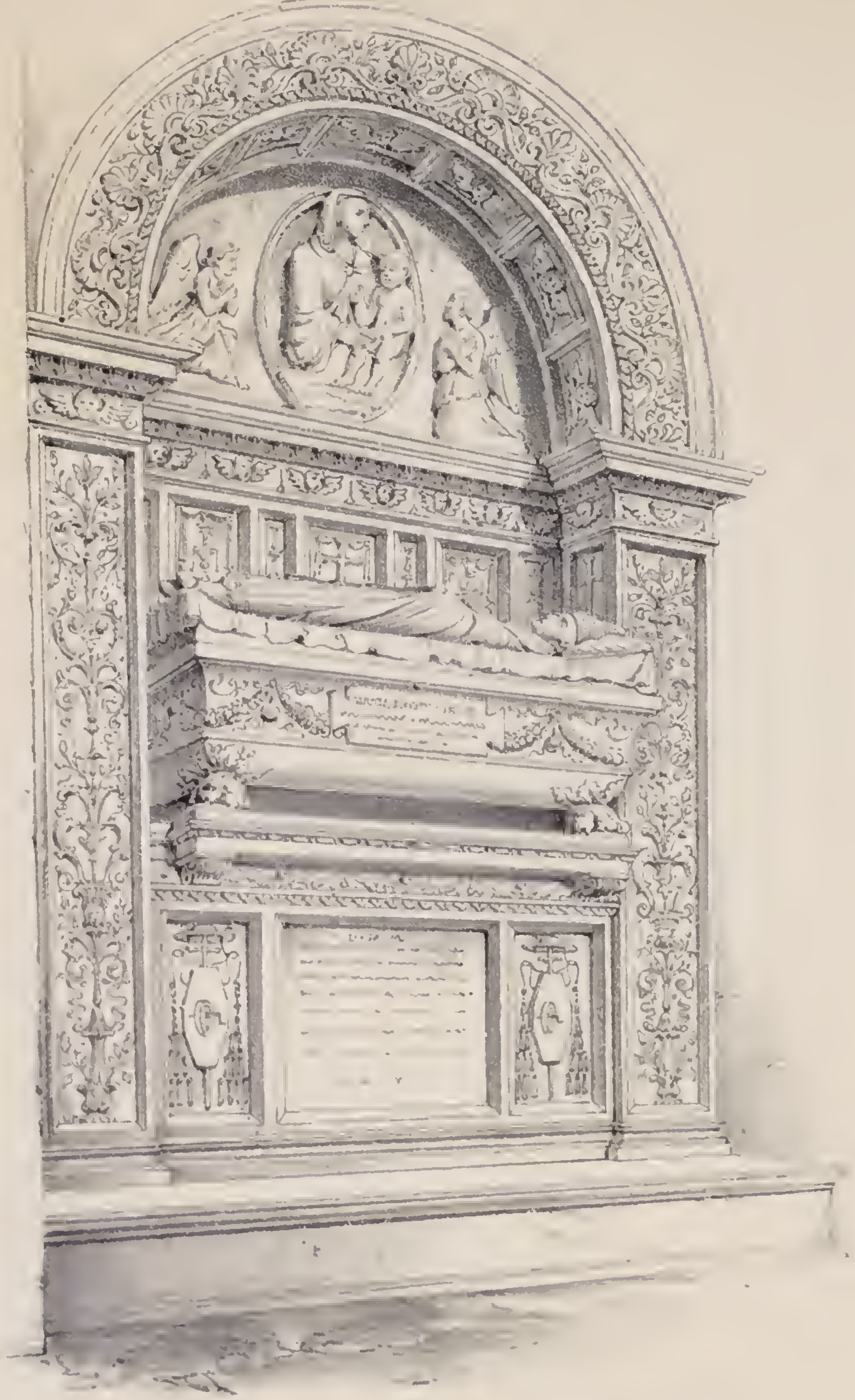
STAIRCASE.

PALAZZO PISANI _ VENICE

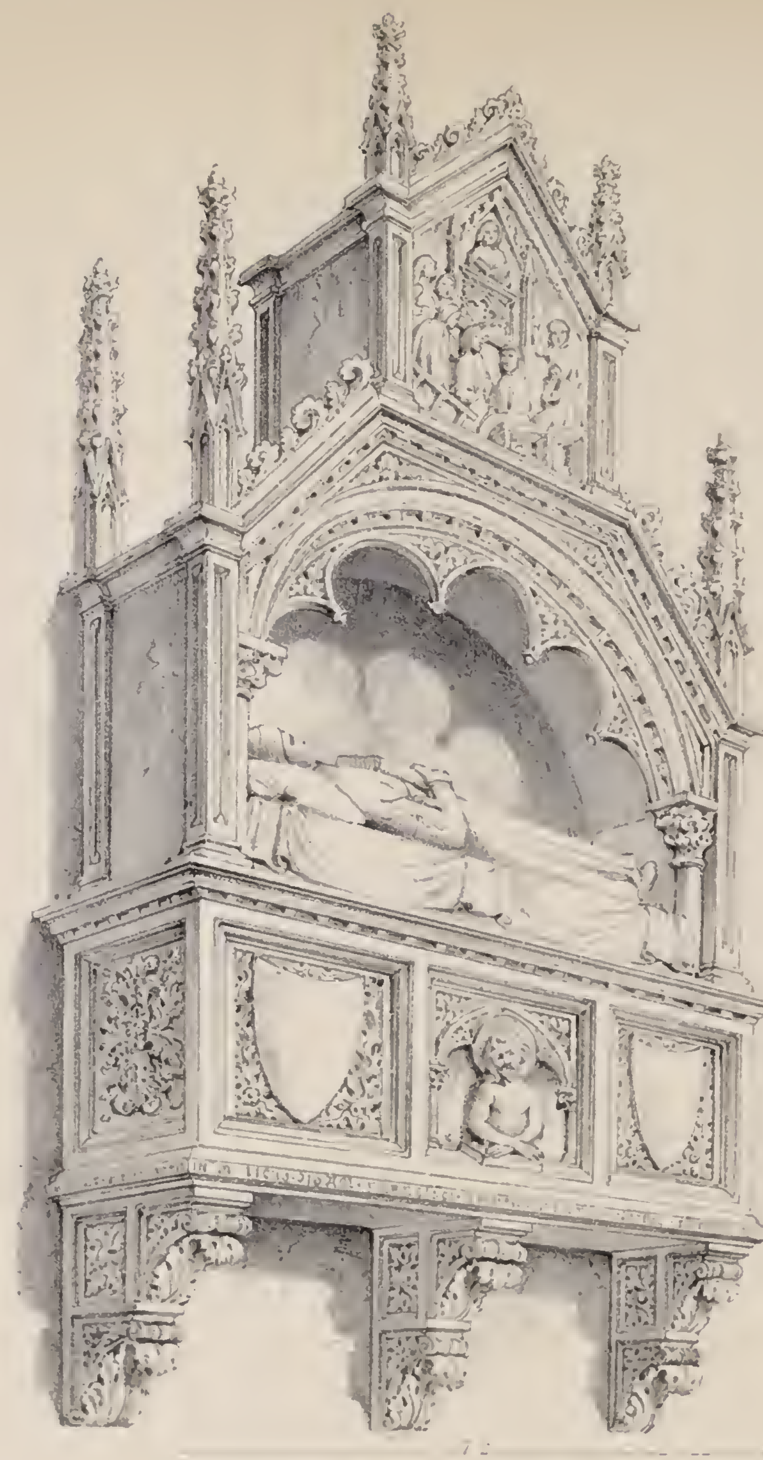


PALAZZO BRASCHI _ ROME

TOMB



ROME
S. MARIA DEL POPOLO



PISA
In a CHAPEL of the CAMPO SANTO.

VENTILATION.

VENTILATION, as applied to buildings, may be defined to be a means for the supply of fresh air, and the withdrawing foul air.

The importance of ventilation has long been recognized; the ancients fully appreciated its value. The Romans, in their architectural arrangements, invariably kept it in view; Varro, Hippocrates, and Galen, knew its importance; the two former succeeded in curing epidemic diseases by making simple openings in the walls of sick chambers; and the latter gave it as his opinion that as a remedial measure in cases of disease it was of great value. Nevertheless the nations of modern times have very much neglected the subject; and it has only been within a very recent period that its paramount necessity has been fully recognized.

To be convinced of the importance of ventilation with reference to the maintenance of sound bodily health, we have only to consider the extreme delicacy, and beauty, of the organs of respiration placed within the human body, by which the inhalation of pure, and the exhalation of impure, air is involuntarily kept in action. While contemplating the complication and extent of the provisions that have been made for this purpose, it is impossible to avoid contrasting them with the comparative indifference that is in general entertained by man himself as to the proper exercise of the functions of respiration.

As being foreign to the practical nature of the following remarks, it is not intended to notice the evidence which has been collected, having reference to the effects of impure air, on the bodily and mental constitutions of parties submitted to its influence. Much has been already written and said on the subject; and the reader, careful of such matters, may derive much useful information from the works mentionedat the close of this article.

The practice of ventilation will herein be treated under three divisions; which may be considered as an elucidation of the plans generally adopted. These may be briefly stated as:

1. Fire draught; and Currents of heated air, *i.e.*, Artificial Currents; 2. Machinery; 3. Natural Currents.

The theory requires only a simple statement. Atmospheric air is composed of nitrogen and oxygen, in the proportion of one part of the latter to four of the former. By the peculiar action of the organs of respiration, the air is drawn into the lungs, there imparting the oxygen or life-supporting principle to the blood; and receiving in its turn the carbonic acid and other impurities. Changed in its composition from a healthy to an unhealthy nature, by the act of expiration it is forcibly discharged from the lungs. This poisonous gas, thus obtained, it is the duty of efficient ventilation to remove from within the zone or range of respiration. In buildings, in addition to this source, the air is vitiated by the products of combustion from candles, gas, and other like causes.

If the reader will turn to the definition at the commencement of this article, he will perceive that two points are there specifically mentioned:—now it must be conceived that it is entirely owing to a misapprehension or ignorance of the real nature of ventilation as there stated, that so many attempts have proved decided failures. Parties who have attempted ventilation by making provisions only for the egress of foul, or for the admission of fresh, air, have wondered why success has not attended their efforts; the reason simply being, that they had omitted the very essence of ventilation as indicated in that definition.

The important desiderata then, are, apertures for the *ingress* of pure, and for the *egress* of foul, air; without provision for both no satisfaction will be obtained. Egress apertures alone, will be totally inefficient in removing foul air from the interior of any apartment, for air cannot by any possibility be removed, unless there is a corresponding admission of purer and denser air to supply its place, in other words, to supplant it and push it out. DR. REID (p. 81, *Illustrations of Ventilation*, 8vo. Lond. 1844) thus clearly and forcibly puts the case. "A moment's reflection will satisfy the mere student as to the truth of the position, that, unless a new portion of air be admitted into any apartment, the portion which is already there will not be expelled. It is necessarily impossible to have ventilation without a movement of air. An ingress and egress might certainly, under peculiar circumstances, be effected alternately by one and the same aperture, and satisfy all the essential wants of nature, as in the case of ordinary respiration, where the mouth and nostrils serve as a passage for air both in inspiration and respiration; but, unless its action were sustained by a mechanism as powerful in proportion to the movement of the air required, and as regular and effective in its operation, it would be vain to expect that it would meet the demands of ordinary ventilation."

In these short remarks, then, it seems to appear, that to ensure the full effect of ventilating arrangements, it is absolutely necessary to have egress and ingress apertures acting in concert; not having one to the exclusion of the other; these being inseparably associated with, and dependent on each other. And at this stage, the question, naturally arising, where is the best place to make the apertures for the egress of the foul air? at the highest or lowest part of an apartment? receives for answer that the highest is preferred without hesitation; and this decision is not given in ignorance that it will incur the opposition of parties who hold the following and reverse opinion: "Air when expelled from the lungs, being composed chiefly of carbonic acid gas, the specific gravity of which is more than one-half heavier than common air, must necessarily have a descending movement and fall towards the ground—consequently it is easiest to withdraw it from the lowest part." But in answer to this, the evidence of every day experience shows, that air in that condition not only does not fall, but on the contrary has an upward tendency, and that moreover one of considerable force.

To prove this truth, it is only necessary to observe, that when we breathe in the open air, in a calm frosty day, we see the vapour, or in other words, the partly condensed breath, fly upwards; if blown forcibly downwards, even then it will be seen to move upwards, as soon as it is relieved from the controlling power; besides, at the floor of a crowded apartment, the air is comparatively pure; near the ceiling it cannot be breathed with impunity; the reverse ought to be the case, were the principle, above noticed, correct. The odour of scented condiments is felt sooner above the head of the party partaking of them, than below the zone of respiration, because the air containing the perfume, being heated, ascends. "The ascending movement is also the natural system—were vitiated air to descend, in a very short time the surface of many districts would become so largely contaminated with it, that disease and death would speedily ensue on every side."

It is to a certain extent true that carbonic acid gas, when highly concentrated, does occupy the lower portion of our atmosphere; witness the Grotta del Cane, old wells, excavations, brewers' vats, etc., etc., but yet it is equally true that when mixed with a considerable proportion of air, or as emitted from the lungs, it invariably moves upwards. If this were not the case, carbonic acid gas would never be found in the upper portions of inhabited apartments; it is there, however, where it is to be found in largest quantities. Again, carbonic acid gas has been found at the tops of the highest mountains.

It is not, however, enough to state that the carbonic acid evolved during respiration does not separate from the gases with which it is mingled; the expired air as a whole, in consequence of its temperature and the moisture associated with it, is specifically lighter under ordinary circumstances than the surrounding atmosphere, being composed of carbonic acid gas, azote, and moisture or steam, each being specifically warmer, bulk for bulk, and weight for weight, than atmospheric air: and, therefore, for a variable period after it is discharged from the lungs, even supposing the carbonic acid not to diffuse itself further in the atmosphere, the vitiated air remains above. If then, the vitiated air be removed by an overhead opening, it will be carried away with the least chance of contaminating the remaining atmosphere. The most rational mode of procedure, therefore, will be to adopt plans in unison with, and dependent upon, the laws of nature; moreover, in accordance with that arrangement which almost universal experience dictates: this has been dwelt upon, as it is important to lay the bearings of the case fully before the reader.

VENTILATION BY MEANS OF FIRE DRAUGHT; AND CURRENTS OF HEATED AIR.

To understand clearly the movements of air induced by heat, it will be necessary to consider the following illustrations. Expanded air becomes lighter and rises, just as oil in water, or the heated particles of water in a boiler rise to the top. Air when warmed by coming in contact with a heated object, or warmed by radiation therefrom, becomes expanded bulk for bulk accordingly. Rising upwards, it is replaced by colder and denser air near it; this is in its turn heated, expansion continually takes place, and an upward current is the result; a rush of cold air follows from the space around it, and thus there is a continual current upwards from the heating object so long as any inequality of temperature exists. Thus in Fig. 1, where a lighted candle is the heating object, the current upwards, as shewn by the dotted lines, is maintained, while the colder air rushes from around, as shewn by the arrows. The effect, then, of a candle, burning fuel, etc., is to draw, from below and around, particles of cold and dense air, expanding and ascending, as in their turn they become heated. The velocity of ascent depends upon the degree of heat of the currents. If cold air come in contact with them, the temperature being reduced, the ascending power will be much diminished; it follows that the more confined the ascending currents can be kept (consistently with free space to move in), the more certain will be their upward flow, and consequently removal. Thus if the candle be placed at the bottom of the tube (see Fig. 2), a quicker rush from below of the colder air will ensue, inasmuch as the heated currents not being accessible to the cooling influence of the external atmosphere, attain a higher temperature; which is accompanied by a corresponding difference of specific gravity, and consequently greater velocity. If the tube be of dimensions proportioned to the heating power, so as to give free space, but not more, to the ascending currents, the upward velocity will be greater than in a tube of larger dimensions. In practice it is found as indicated in theory; that as the products in a narrow tube are less easily cooled by the surrounding atmosphere, the temperature is higher, and velocity is quicker, than in a large and wide tube.

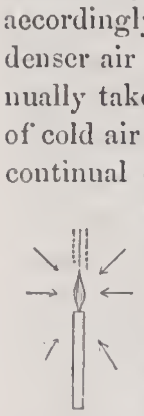


Fig. 1.

Fig. 2.

The altitude of the tube exercises a very important influence on the velocity of the upward currents. The higher the tube the greater the velocity; a column of four feet rises with twice as much force as one of two feet, and so on in the same proportion. Dr. Arnott (p. 403, *Elements of Physics*, 8vo. Lond. 1828) observes justly, that "as two or more corks strung together and immersed in water, tend upwards with more force than a single cork; or a long spear of light wood allowed to ascend perpendicularly from a great depth of water, acquires a velocity, which makes it dart high above the surface; while a short piece under the same circumstances rises very slowly."

Another thing, which influences the rise of heated currents in a tube or chimney, is the degree of heat which is imparted to the air. This will be seen to determine the amount of dilatation or expansion, which causes it to ascend. Thus in an open fireplace, the air finds entrance to the flue, above as well as below the burning fuel—mixing with the hot air ascending directly from the burning mass, it reduces its temperature and consequently its ascending force. If the air, by stopping up the open front of the fireplace, is forced to pass through the ignited fuel, it is so very much raised in temperature, that the velocity upwards is materially increased.

Descending currents can be maintained by the power of fire draught. Thus in Fig. 3, the cold air descending *b*, to supply the

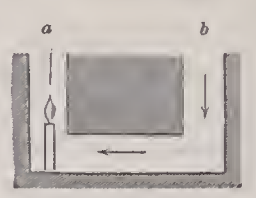


Fig. 3.

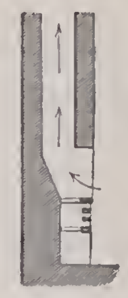


Fig. 5.

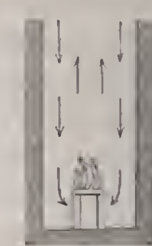


Fig. 4.

demand, ascends *a* heated. Again in Fig. 4, a fire placed at the bottom of a pit draws its supply of air from above. Fig. 5 is an exemplification of the upward currents produced in an open fireplace. If the chimney be very wide, Fig. 6, or if the supply of air from below be defective, the fire draws its supply down the chimney; then there are in such cases two currents produced, one up, the other down, and the ascending current coming in contact with the descending cold current is reduced in heat and velocity of ascent. If an aperture be made in the side of a flue, as at *a*, Fig. 7, a current will be established through it; the upward force of the draught in the flue carrying the air from the aperture up the interior of the flue. If the reader has carefully noticed the foregoing illustrations, he will be prepared to understand the following suggestions.

Fig. 6.

Fig. 7.

In determining to produce the ventilation of an apartment, or suite of apartments, by means of fire draught, the plan to be adopted will depend upon one of two ways, viz. either the construction and maintenance of fires or furnaces, whose air, to support combustion, must be drawn only from the apartment to be ventilated, the connexion being kept up by means of flues, shafts, or pipes; or by taking advantage of the upward current of some flue or furnace chimney, which may already be in contact with, or placed near the building. Thus in the case of a small steam engine connected with a warehouse, pipes may be led from the interior of each apartment, communicating with the interior of the flue of the engine furnace.

In the former case, the fireplace or furnace should be placed at the *lowest* part of the building, erected in a separate chamber, carefully made fire proof; or placed at the bottom of the upright chimney or flue, prepared to carry off the products of combustion. If the safety of the building and the other arrangements will admit of it, it would be better in all such cases to have the furnace at the *highest* part of the building. The benefit to be derived from this arrangement, although obvious, may be here

stated; the natural course of heated air being upwards, greater force must be maintained to cause it to take a downward course; in one case it must be controlled, in the other merely assisted. It is clear that as the fire is the power in both cases, a larger expenditure of fuel will be necessary to maintain currents opposed to, than others in accordance with, natural laws. But fortunately, air, if *finally* allowed to escape by an upward course, can be led horizontally, laterally or downwards, always however be it recollected taking a greater power in such cases. Fig. 8 will illustrate the manner in which the currents are produced by fire draught; the fresh air is introduced at the floor, and

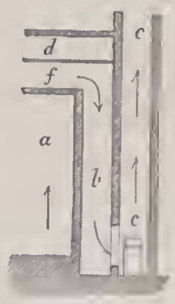


Fig. 8.

ascending to the ceiling, as at a, it passes through the space between the ceiling and the roof, through apertures made in the former; the fire at c draws its supply of air solely from the flue or passage b, producing a current downwards, which in its turn acts upon the air within the space $f\,d$, withdrawing the air therefrom, and consequently (through the apertures in the ceiling) the air contained within the apartment. Care should be taken to have the spaces into which the air is drawn, not larger than is essentially requisite. Thus where the space between the roof and ceiling of a building is very large, it would be better to have the apertures in the ceiling through which the air is to be withdrawn, made in the centre in a line with one another. A wooden box should then cover all these, running along the ceiling, closed at one end, and communicating at the other with the descending flue leading to the furnace. The double line d, Fig. 8, shews the position of this box, and the mode of preventing the foul air from spreading in the upper part of the space.

In a suite of apartments, the apertures for the withdrawal of the foul air should be made at the connection of the cornice with the ceiling, or as near the ceiling as possible, communicating with flues made in the walls; the whole of which should lead into the large descending flue. Instead of making an aperture along the cornice, as above named, an opening, circular or otherwise, might be made in the ceiling of each apartment, leading by a small passage to the great flue.

In making provisions for the withdrawal of the foul air from a large apartment, the apertures near the large flue should be less in number, or of area, than towards the end furthest from it. The reason for this arrangement is, that, as the withdrawing force of the flue is greater near its influence than when further from it, a greater area is requisite the further the apertures are from it, less being drawn through them in a given time.

All apartments should be largely supplied with pure air, *i. e.*, not less than four cubic feet per minute for each individual. It should be admitted at the lowest part of the chamber. In rooms having an outside wall, apertures might be made communicating with the space behind the skirting, or led beneath the flooring, to some convenient space where a grating may be placed, or small apertures bored in the flooring. In all cases the air should, on entering, be as much diffused as possible; this may be easily effected by placing before the apertures sheets of zinc perforated with small holes, horse-hair, or cocoa-fibre cloths. The smaller the interstices, and the more diffused, the less palpable will the current be.

In place of supplying each apartment with air through apertures in the outside walls, the corridors or passages may be furnished with fresh air, from which the rooms can be supplied; to effect this, a slit or opening may be made in the partition, or at the foot of the door; the best way, however, would be to lead air beneath the flooring, communicating through apertures in the centre of the room, or at the skirting-board.

In ventilating so large an apartment as a church, the fresh air can be admitted easily through apertures in the outer walls; these should be placed on all sides, and be furnished with valves (hereafter figured) as regulators. The air flues should have small zinc frames, attached within a few inches of the entrance, these frames being provided with sheets of finely perforated zinc, which can easily be removed from time to time, in order to be cleansed. Immediately behind the frame, the air flue may be enlarged; this will check the velocity of the passing current, and supply a vacancy, in which the extraneous particles of dust may be lodged. The air can be most conveniently carried to grated apertures in the passages or aisles; yet if it be required to have a greater diffusion of the air, the most effectual plan will be to have a dry chamber beneath the whole extent of flooring, well supplied with air, and the flooring-boards perforated with innumerable small holes; the smaller these are, the better will the air be diffused. If this plan is adopted, it will be essentially necessary to have the air heated in cold weather. (Heating.)

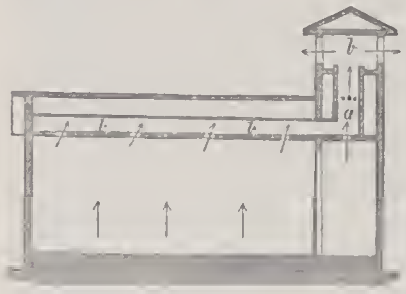


Fig. 9.

As in all cases there is a loss of power where a descending current is established, the used air may be led in the case of a church with a turret, to the inside thereof, by means of a ventiduct. The withdrawing power to be placed here will be best supplied by a "gas rarefier", which, if of sufficient size, will act very powerfully. Fig. 9 illustrates this mode of ventilation, where $b\,b$ is the ventiduct, a the gas rarefier; the fresh air is admitted near the flooring.

Fig. 10 illustrates the maintenance of a descending current by means of a gas rarefier; the fresh air is admitted to the various apartments at $a\,a\,a$, the vitiated is withdrawn through apertures at the corners, as at $b\,b\,b$: c is the gas rarefier.

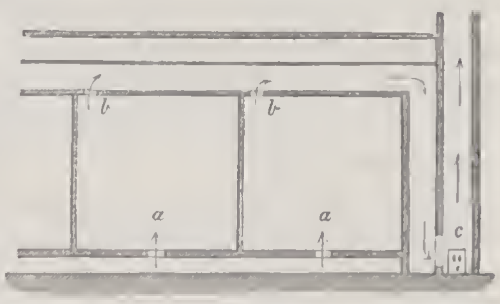


Fig. 10.

At the Unitarian chapel in Hope Street, Liverpool, and all other places where this gas rarefier has been adopted, it has been most successful. In place of it, if a congeries of pipes connected with steam or hot water apparatus be placed in the ventiduct, an upward current will by this means be created, and maintained so long as the heat is kept up. The pipes may either be coiled spirally in the interior of the shaft or turret; or, as in the plan recommended by Mr. Sylvester for the House of Commons, they may reach across the space formed between the roof and ceiling. In large buildings, where a steam-boiler is used, the plan of ventilating by means of a steam-jet, or jets, may be adopted with advantage; it is a very simple and effective mode of withdrawing foul air. High-pressure steam is projected upwards in the interior of a shaft, through small jets or pipes; the heat, acting on the surrounding air, rarefies it, and causes it to ascend; and the friction of the steam also acts upon the air, just as a small stream of water, projected forcibly through a body of water, carries along with it a considerable volume, or as the jet in a locomotive engine, increases the draught. But there is yet another cause, by which the efficiency of a steam-jet as a ventilating power is maintained. The steam, on issuing from the jets, does not spread itself in all directions, without assuming a determinate form; but it expands conically, the base of each inverted cone occupying space in the shaft, and acting somewhat as pistons to push up the air. But the writer is inclined to think that the jet obtains its efficiency, chiefly from the friction it has with the surrounding air, and from its contained heat rarefying the air with which it comes in contact. Mr. Tomlinson (*Warming and Ventilation*, p. 241, 12mo. London, 1850) points out a plan, by which a suite of apartments may be ventilated by the heating power of hot-water pipes; it appears to possess peculiar advantages, but will require to be adopted in the original construction of the building. Flues are to be left in the walls, and provided with communications opening to each apartment near the ceiling; the egress of each flue

is to be at the top of the house, and each carefully guarded at top, to prevent rain, etc., descending. It is evident that the heat communicated by the pipes placed in the interior of the flues, will cause an upward current therein, and consequently the air in the apartments will be withdrawn through the openings. In summer time, when the range of pipes placed in other parts of the building, are not in use, stop-cocks may be provided, by which the hot water will be confined to the pipes in the flues. By this arrangement, a continual withdrawal of air will be going on at all times, the expense of keeping up the heat being exceedingly slight. Gas rarefiers may perhaps be cheapest in ascending flues, and most conveniently fitted up at first; although steam or hot water pipes would require no attention and be very safe. If gas is used, care should be taken to have it placed in a fire-proof chamber, having no near connexion with wood.

Having thus concisely explained the principles of ventilation as maintained by exclusive furnaces or heating powers, we have now to consider the best means of taking advantage of casual sources of fire-draught, as chimney flues. The most celebrated adaptation of the working power of a chimney flue is that of Mr. Fleming of Glasgow, who successfully ventilated a long range of buildings, called the Barracks, occupied as dwelling houses by factory workers. In this place, before the ventilating arrangements were adopted, fever was scarcely ever absent, and the mortality amongst the inhabitants very great. The plan adopted was simple. A pipe communicating with the interior of the flue of the factory furnace was led from the interior of each room near the ceiling. From the rapidity of the draught in the chimney, the air was very speedily withdrawn from the range of apartments.

In large buildings where there is a fire-place or furnace used in the lower part of the building for heating purposes, advantage should be taken of this power for ventilation. The simplest mode of doing this, is to lead a pipe from the space between the roof and ceiling of the large apartment, or from the flue into which the foul air passages meet, down to the ash-pit of the furnace. To prevent the air having access to the fuel through any place, save this pipe, the furnace-door should be made as tight as possible, and the open space in front of the fire leading to the ash-pit, covered in with an air-tight cover. This should be made so as to be easily removed, to stir the under part of the fuel when necessary, and yet perfectly air-tight, or as nearly so as possible, when put in its place; as the fire will draw down its supply of air through the pipe alone, the suction then through it will be of considerable force. Unless the furnace is very large, the force of the downward current in the pipe will only suffice for a moderately large apartment; the plan may, however, be adopted, as a valuable auxiliary to other ventilating arrangements.

The most effectual plan of taking advantage of the full working power of such a furnace, will be as follows. Let the room, in which the furnace is, be made as small as possible, consistently with convenience for adjusting the fuel. Let the door of this room be also as small as possible, and be made to shut perfectly air-tight; and let the air which is to supply the furnace come only through a flue, having communication with the apartment to be ventilated: the furnace, being supplied solely through this flue, will exert its utmost withdrawing force.

If the reader will turn to Fig. 7, he will see how an upward current can be established, through an aperture made in the chimney above the supporting fire. It is on this principle that air can be withdrawn from apartments by openings, or by pipes communicating with openings in flues. In ventilating apartments in dwelling-houses, etc., advantage should always be taken of the controlling power of the chimney flue. The apartment should in the first place be well supplied with fresh air; for this purpose, apertures may be made in the walls, or the supply may be taken from the corridors or passages, as before described. In using the ascending power of the currents in the chimneys of apartments, the great desideratum is to have the aperture so arranged as to prevent the smoke issuing into the apartment. From the defective construction of fire-places and chimney-flues (CHIMNEYS), down draughts are of very frequent occurrence, it therefore becomes necessary in adopting foul air apertures, to use such only as will prevent the smoke from entering the apartment. Dr. Arnott's ventilating valve for apartments is well known. It may be briefly described as a square tube of iron, inserted in the wall near the ceiling of the apartment. The tube communicates with the interior of the chimney-flue; thus making a passage from the interior thereof to the apartment. At the end of the tube nearest the apartment, a valve of a peculiar construction is fastened. This valve opens inwards, admitting air to pass it from the apartment, but closes when smoke is forced along the tube from the interior of the chimney. Fig. 11 is a representation of the principle of the valve; where *a* is the valve, the arrows shew the manner in which the currents act upon it; *b b* is the wall; *c*, the tube. If a tube without the valve be placed in the wall above the fire-place, as near the ceiling as possible, it will be effectual in withdrawing the air from the room, if the chimney is properly constructed so as to prevent down draughts. If a simple tube be used, the mouth of it could be masked by open ornamental work. The following is a sketch of a room ventilator recently introduced by Mr. Wm. Bryden, of Edinburgh. Fig. 12 shews the two views of the ventilator. A hole is cut, near the ceiling, in the wall of the apartment to be ventilated, communicating with the flue above the fire-place; in it is inserted a conical or funnel-shaped tube, as shewn in the illustration A. At the side in the room is placed a lid, hinged as seen in the elevation B at *g*, and kept close by a button, or clasp, at *f*. At the centre of this lid, exactly opposite the small or straight part of the tube, there is a solid part, of the same diameter, at *c*; this solid part should be a little larger than the smallest part of the tube. The remainder of the lid between the two concentric circles, as at *d*, is punctured full of small holes; the aggregate area of which should be equal to that of the straight part of the tube. The upward current in the flue, *a*, draws the air from the apartment through the apertures *d*, as shewn by the arrows in the sketch to the left. If there should happen to be a down-draught in the chimney, the smoke passes along the tube and is thrown against the solid part *c*, and spreading up in the funnel part is carried back again to the chimney by the force of the renewed current. Where good precautions are taken to prevent down-draughts by the proper construction of chimneys, a better contrivance could not be adopted than this. It has been perfectly successful in all cases where adopted. In the summer the current may be forcibly maintained by having a gas jet burning, as seen in the sketch; this will not be expensive, not observable in the room, and render the plan thoroughly efficient at all times. In a well constructed chimney no down-draught will take place, and a simple tube without any valve will act well in withdrawing vitiated air from any apartment.

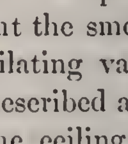
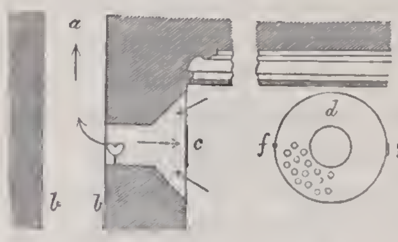


Fig. 11.



A Fig. 12. B

The reader will perceive how easily the apertures of all those contrivances can be ornamented, and made to add to the decorative appearance of the apartment. In place of apertures in the wall of the apartment, as above described, a tube may be concealed behind the cornice leading to the chimney; or a passage or flue may be made in the interior of the stucco-work. In either of these plans, the slit or opening leading from the apartment to the interior of the tube or passage, should be of less area near the fire-place than further away from it. If a tube is used, it may be carried a few feet up the chimney; and then, it being considerably heated, the ascending force of the interior current will be materially assisted; a cap of a simple

construction may be placed at its termination to prevent soot falling down it.

Another plan is to make in the centre of the ceiling a circular space, of diameter proportionate to the size of the room (say, for a room of 14 feet square, 10 inches diameter); this may be made some three or four inches deep, arched or curved on the upper side. From the side of this aperture, a pipe or tube may be led to a flue made in the wall, leading to the external atmosphere. If the joists run transversely to the length of this pipe, holes will require to be cut, to allow of its passage; but as in London, and most country houses, the joists are not deep enough to allow of this being done, there will be a limit to this plan. If the trimmer would allow of it, and sufficient space were left between the plaster and the beams, it would be a good plan to lead the pipe direct to the chimney-flue; but the practical difficulties in the way prevent this being done, although in some cases it has been effected by Mr. Gilbody of Manchester, by leading the pipe through a hole cut in the trimmer. Mr. Walker of Manchester, has recently registered a "ventilating chimney tube", which promises to be useful (for full description of this plan, see CHIMNEYS); it consists of a tube of earthenware, the usual size of a chimney-flue, but with the corners rounded; at one side a tube, of length equal to side of flue, but in breadth much smaller, is attached, or rather moulded in the same piece; the side of this flue is formed by one of the sides of the smoke-flue. The heat of the smoke, etc., is communicated to the smaller flue, the air therein is rarefied, and an ascending movement is the consequence. It is evident, that if an aperture be made, communicating with the interior of this flue and the apartment to be ventilated, an upward current of air will be the result. It is obvious that this idea is susceptible of being carried out in various forms, according to local circumstances.

From the examples thus given, there should seem to be no difficulty in ventilating any public building or private apartment; and if any of the modes stated do not seem convenient to be adopted, yet the principles upon which success depends being so plainly laid down, the architect will easily design others, which will meet the circumstances of the peculiar case to which he may wish to apply them.

MECHANICAL VENTILATION BY MEANS OF FANNERS AND SCREWS.

As the arrangements regarding flues and passages are the same as those rendered necessary for ventilation by fire draught, it will be necessary to dwell but very shortly on this branch. Instead of sustaining the currents by means of fire, the machines above indicated are used. There are two plans in which they are adopted; these are what are called the "plenum" and "vacuum" impulses. The former is where the power of machinery is used to force fresh air into the interior of an apartment, the foul being allowed to go out by crevices, or through apertures made in the apartment. The latter is where machinery is used for withdrawing the foul air, the fresh being allowed to enter through apertures made for its admission; fire draught acts upon the vacuum impulse.

The fanners have long been in use; they were described by DESAGULIERS (*Course of Experimental Philosophy*, vol. ii, pp. 563, 568; *Philosophical Transactions*, vol. xxxix, No. 437), and have since been made in a variety of forms. The form shewn in Fig. 13 is that most commonly used, and is very effective; *b* is a side view; *a* a sectional plan. All fanners draw in air at the centre, and discharge it at the circumference; this is shewn by the arrows in the sectional plan. Fanners are also made with curved blades; but there is yet much diversity of opinion relative to the best form of these portions. Some practitioners hold that much advantage is derived from the use of curved blades. The sides of some fanners are entirely open, drawing

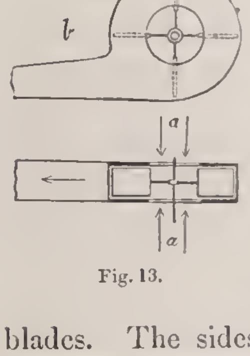


Fig. 13.

in air on each side of the blades, instead of through an aperture in the centre, as shewn in Fig. 13. The circumference of others is also left open. This latter form of fanner is very powerful in discharging air.

There has recently been patented, a very important improvement in the fanner, by Mr. Lloyd of Southwark. Fig. 14 shews the form of blades, differing materially from those generally used. The tapered blades *a b a* are attached by rivets *c c* to the arms *d*; the blades, instead of being flat, are curved, forming portions of a spiral. The blades are of the ordinary width at the central holes, but taper to a breadth not more than from one-sixth to one-twelfth of that width, according to the purpose for which the fan is required. Conical-shaped side-plates of sheet-iron are accurately fitted to all the edges *a b* of the blades, forming an inner case, with a central hole in each for the admission of air, and a space betwixt their peripheries, the same width as the tips of the blades, for its discharge into the outer or usual case. In the ordinary fanners, the blades are of a square form, as wide at their tips as at the centre, and are not attached to any internal case. Now, as the spaces betwixt the blades continue to increase from the centre outwards, it is clear that the air which is drawn in at the central holes, will not be sufficient to fill the larger space, the circumference of which is described by the tips of the blades; it therefore follows that there must be more or less of a vacuum formed behind each blade when revolving, and that the air which is condensed in front, will rush over the ends and sides of the blades, to fill up the vacuum so formed. It is this process continually going on, when the ordinary fanners are working at a high velocity, which causes the disagreeable humming so frequently complained of. In the improved fan which we have above described, however great the velocity, no disagreeable noise is produced; a fan fifteen inches in diameter, and revolving 1500 times per minute, is perfectly noiseless. This noiselessness is caused by the opening in the periphery of the inner case, not greatly exceeding in area that of the nozzle of the discharge-pipe; the air consequently passes quietly and smoothly through the passages, the side-plates preventing any reflux of air upon the blades. No power is lost by beating or "grinding" the air, which happens in fanners of the ordinary description, revolving at high velocity; as the blades gradually decrease in width to the tips, where their velocity is increased. It is asserted by the patentee, that the result of repeated trials, in the presence of many scientific gentlemen, fully proves that, compared with other fans, size and other circumstances being alike, the same intensity of blast is kept up by the improved form, with the expenditure of half the power required to drive the former. A fan of the improved construction, fifteen inches diameter, revolving 1500 times per minute, will throw in air at the rate of 500 cubic feet per minute. A fanner of twenty-five inches diameter, the velocity of periphery of inner case being 11,000 feet per minute, keeps up a continuous blast through a nozzle, the area being fifty inches, supporting a column of water four inches high. The form of fanner above shewn in Fig. 13, has its outer case concentric with the tips of the blades; the improved form, called the "eccentric", discharges more air than this, inasmuch as, in consequence of the central axis of the fan, being out of the centre, of the outer case, a large space is left at the back, into which the air is compressed in the spiral course by the revolving blades. In the concentric form there is considerable loss of power, from a quantity of air being carried round by the blades, in place of being discharged at the orifice in the circumference. When fans are used for withdrawing air, the openings at the side are inclosed within caps, with which the tubes from the ventilating flues communicate, the area of these apertures being of course, in all cases, equal to the area of the flues. Valves may be placed, for regulating the withdrawing

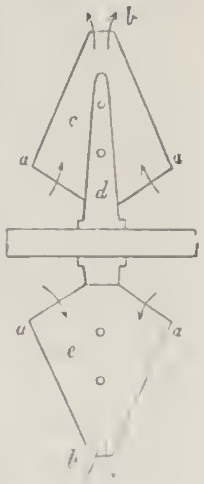


Fig. 14.

or blowing power, in the pipes or flues, or in the caps at the sides of the fan. There is no part of the subject of ventilation about which so little is known, as data of the working of fanners and screws. Each practitioner has his own plan ; some recommend screws, others fanners; and in no instances scarcely do two parties agree as to results found. If the experiments with fanners instituted by some were to be given, it would involve the mention of all others ; this would be a matter of some difficulty, and would occupy larger space than may be considered necessary. As a guide in the calculation of size of fanners, the following extract from Mr. Tomlinson's work (p. 189) is given, as it possesses the advantage of containing much information in little space :—"The fan produces its greatest effect, when the extreme points of its leaves move through about eighty feet per second. The mean velocity of that portion of the vanes by which the air is discharged, is about seven-eighths of the velocity of the extremities ; but owing to the inertia of the air, there will be a loss in the velocity of the issuing current, which will increase with the increased speed of the vanes; so that, in general, the current will be discharged with a velocity equal to about three-fourths of the velocity of the extremities. This velocity, measured in feet per second, multiplied by the area of the discharge-pipe in square feet, will give the number of cubic feet of air discharged per second. If the effective velocity of the vanes be seventy feet per second, and the sectional area of the discharge-tube be three square feet, then $70\times3=210$ cubic feet of air discharged per second, or 12,600 cubic feet per minute. As a cubic foot of air weighs 527 grains, there will be about 13 cubic feet of air to a pound ; therefore $\frac{210\times60}{13}=969$ lbs. weight of air set in motion per minute, with a velocity of seventy feet per second. The height from which a heavy body must fall, in order to acquire a velocity of seventy feet per second, is 76·5 feet, which multiplied by the number of pounds weight moved per minute, will give the power necessary to discharge this quantity of air at the stated velocity ; and this product, divided by 33,000 (the number of pounds weight that one horse will raise one foot high per minute), will give the amount of steam-power required. Therefore $\frac{76\cdot5\times969}{33,000}=2\cdot24$, or nearly $2\frac{1}{4}$ horse-power, will be required to discharge the given quantity of air at the velocity stated." But it is needful to observe, that both theorists and practical men are found to disagree considerably among themselves, as to the effective results of any form of these machines. It may also be added, that a ventilating screw, four feet in diameter, revolving four hundred times per minute, is estimated to deliver four thousand cubic feet of air in the same space of time; the power required being equal to that of two horses, according to Watt's formula.

Various modifications of the Archimedian screw have been adopted for ventilating purposes. Mr. Combe, late of Leeds, has introduced, with great success, a double threaded screw in Messrs. Marshall's cloth factory in that town. Screws, as well as fanners, can be used for extracting or forcing air, according to the direction in which they are made to revolve.

In determining to adopt the fanners for forcing a supply of air into apartments, it should be borne in mind, that it is the quantity of air that is required, not the velocity with which it is propelled ; that the larger the channels made for the purpose of *leading* the air to the place required, the better : that large fanners are worked with greater economy than small ones; and that it is a general rule, that more satisfaction is attained by working with large fanners at a slow speed than with small ones at a considerable velocity. When small fanners are wrought at a high speed, a very disagreeable noise is created.

Care should be taken to have the apertures for the discharge of the foul air of sufficient size ; in a church or similar building these can communicate with the external air, through the common shaped louvres on the roof; or the air may be led to the turret or spire. In using fanners to withdraw the foul air (that is, by the vacuum impulse), the channels leading from the highest part of the building should all lead into one large flue, which may descend in the same manner as in fire-draught ventilation; but such a plan will require additional exhausting power. To have the full advantage of the machine, the better place would be near the roof, at some position higher than all the air channels leading from the apartment beneath. The fanners could, however, be easier wrought near the ground, and this convenience may be considered worthy of being attained by providing additional exhausting power.

The annexed figure shews the arrangement for forcing in air to an apartment. *a*, is the fanner propelling the air beneath the floor, through which it passes by apertures made therein. The vitiated air is forced up by the current through the ceiling, and out at the louvre shaped opening, *c c*, to the external atmosphere.

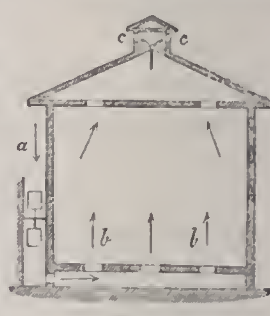


Fig. 15.

The next figure shews the arrangement to be adopted for extracting the foul air by means of the fanner *c*, placed at the bottom of a flue. The air should only have access to the centre of the fanner, or the size should be proportioned to the size of flue; if this is the case, so as to allow no air to escape but through the influence of the fanner, and the circumference be left open, the utmost effect will be obtained. The size of the fanner will depend upon the width of flue ; and the rate at which the vanes revolve, as shewn above; if the air is led to the centre by caps and pipes, the area of these must be equal to the area of the flue. The size of fanners must be left to the decision of the architect, as to whether he will prefer to carry off the *same quantity* of air by small fanners working at a high velocity, or by large ones working at a slow speed. The discharged air passes out from the chamber at *a*, along the space between the roof and ceiling, down the flue, drawn in by the action of the fanners, and finally discharged to the external atmosphere at *f*. In each of the arrangements thus indicated, the screw may be adopted in place of the fanner, yet, from the certainty and simplicity of its action, and the satisfactory results generally obtained from it, the adoption of the fan may be recommended. Mr. Walker of Manchester has recently invented a direct action engine of extreme simplicity for working screw ventilators; but it may of course be applied to fanners. Dr. Arnott has invented a species of pump for supplying fresh air to apartments, which when judiciously constructed and worked, is very efficient. It may be briefly described as a pump having large cloth valves ; the rate of speed is moderate, but from the extensive surface of the valves generally adopted, a large quantity of air is sent into the apartment. *a a a a* is the external casing, containing the internal cylinder or pump *d d d d*, in which the piston *c c* works ; the partitions *f f* make four divisions, each provided with one, two, three, or more valves, one set of which open inwards, the other outwards; as the air is entering by *e*, it is projected through *k* ; on the piston descending *k k* close, *e e* shut, and the air beneath, prevented from going out by *e e*, passes through *g g*, the air entering above the piston by *h h*. The ease with which it may be worked, and the cheapness of fitting it up, as compared with fanners or screws, will be evident. A large pump of this description may be made for a few shillings ; the quantity of air which it delivers is exactly proportional to the cubical contents of the pump and the rate at which the piston *b* works. In the one fitted up at the House of Lords, worked by a small direct-action engine, the size of the pump is 8 feet square, having a sectional area of 64 feet ; the sizes of the side-valves, 9 inches broad; in length, equal to the length of side of pump : the piston of wood, working easily, makes fifty strokes per minute, delivering, in that time, 12,800 cubic

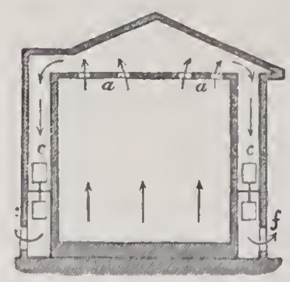


Fig. 16.

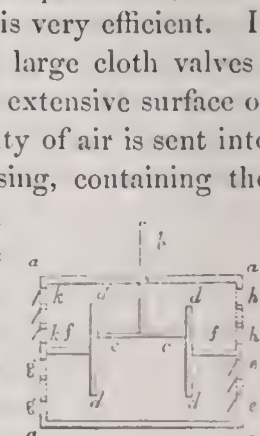


Fig. 17.

feet of air—one-third being deducted on account of friction. The side valves are made of oiled silk, lined with green baize.

An opinion prevails to a very considerable extent amongst practical men, viz., that fanners are more powerful in exhausting than propelling air. That this is not the case, a moment's reflection will abundantly prove; they only exhaust what they propel; what is forced out at one side is equivalent to the quantity drawn in at the other. The power of exhaustion and propulsion is therefore in all cases equal.

Wherever machinery is proposed for adoption, the vacuum impulse has strong claims to recommendation. Parties have advocated the plenum impulse not only from the unity of atmosphere which it developes in the apartment into which it is introduced, but also from the superior advantages which a dense atmosphere is supposed by them to possess over that which is comparatively attenuated.

Reid (*Illustrations*, p. 121) observes, in answer to these arguments, that "the mere density of the air supplied in any ordinary building cannot, however, I apprehend, be a matter of any real consequence, as whatever density may be given to air by machinery, or in the leading air channels immediately attached to the pneumatic machine employed, it is not practicable to communicate any considerable increase of density in any apartment at a reasonable expense, so long as communications with the external atmosphere by doors or otherwise are not placed on a very different footing from what they are at present; nor, when the fluctuations of the barometer are so considerable from day to day, can it be supposed that any action less in intensity than what is continually produced by this cause, can be likely to exert any very sensible effect, while at the same time, it is not unfair to conclude that the pressure which actually obtains at the surface of the earth must be considered the best for the maintenance of health and strength both of body and mind."

VENTILATION BY MEANS OF NATURAL CURRENTS.

Natural, as opposed to artificial, ventilation (understanding by the latter term all plans requiring arrangements, of whatever nature, to be constantly and exclusively maintained), may be defined—the maintenance of currents in the air of apartments by a process similar to that by which movements in the external atmosphere are created and upheld. It has already been shewn "that the specific gravity of air vitiated by respiration or combustion (the two great processes that deteriorate air in ordinary buildings), is under ordinary circumstances less than that of common air; it gives way accordingly, and is pressed up by the purer and denser air." If the reader will turn to the preliminary remarks, in the first division, upon the modes in which heated currents are produced, he will find that air when heated becomes expanded, and that its upward force depends upon the temperature and consequent degree of rarefaction or expansion. Air when expelled from the lungs is heated (this heat is principally that which is derived from the animal heat of the body), it therefore has an upward tendency. The sooner air, then, is withdrawn from the room in which it is vitiated the better; and the more certain will its withdrawal be, if this is effected before the temperature is reduced. If these remarks be understood, the reader will perceive the truth of the following explanation of natural ventilation; and the benefit to be derived from carrying out the suggestions thereafter given. "Imagine", says Reid (*Illustrations*, p. 92), "an apartment occupied (not inconveniently crowded) by a number of persons standing on a porous floor, and the roof taken off; at ordinary temperatures the air vitiated there by the human frame requires no mechanical power to remove it. The superincumbent pressure is diminished by the expansion of the air as it is heated; but the external atmosphere is permitted to have free access below as well as above, to the porous floor. Its power therefore preponderates, and an upward movement is the necessary consequence, which is accompanied by the introduction of fresh air, and the removal of that which is vitiated. Here, then, is a species of natural ventilation. All that is essential is merely this, that the natural movements induced by the heat of the body shall not be stopped by any barrier which may be opposed to them. An open roof and ceiling, however, is in the greater number of climates indispensable. Protection is required from the weather independent of other arrangements, the opening accordingly may be contracted. In proportion to the amount of contraction, the temperature of the air, and the numbers on a given space, it now becomes necessary to increase the velocity of the discharge from the apartment referred to. To effect this, if a shaft or chimney be extended from any opening in or near the ceiling, the column of warm air which soon fills it increases its power: and, unless an extreme number of individuals be crowded in the apartment, the shaft is sufficient for all ordinary purposes. It acts at all times when the density of the air within is less than the density of the air without; and when this is not the case, its power can still be developed by kindling a lamp or fire, or *merely by increasing the temperature of the apartment* for which it is supplied, as any of these cases produces the necessary diminution of density or rarefaction within, on which its force depends." Too much attention cannot be paid to this excellent illustration; if it be thoroughly understood, all the necessary arrangements will be easily made out.

In ventilating public buildings by the system of natural ventilation, the first important requisite is the admission of fresh air. The apertures for its admission should be made in the walls as near the bottom as possible. If there is an unoccupied space below the flooring not damp, the air may be allowed to disperse itself there, finding access to the buildings through apertures in the flooring. If this plan be not approved, or if any chamber be beneath the apartment to be ventilated, the fresh air should be led to the passages through pipes or boxes leading from the apertures made in the outside walls. Gratings should be put at the openings to which the air is led, placing at the under side of them plates of finely perforated zinc to diffuse the air as much as possible. As in some cases, from the nature of the ground at the foot of the walls, the air there is not well fitted for respiration, it is better to draw the air from the top of the walls. The following sketch (Fig. 18) shews how this may be done. In the walls lead up hollow passages or flues, as *c c*, communicating at the top with the external atmosphere, and at the bottom with the space below the flooring, or with the boxes or flues leading to the passages, as shewn at *d d*. The inside of these internal "flues" should be as smooth as possible, and have easy curves; circular stone-ware pipes can be used with advantage for such purposes. There is considerable friction in rough stone flues, so that the smoother they are, the better will the purpose be answered. The apertures for the admission of fresh air should be provided with valves capable of being opened or shut to any extent or required degree. The following may be cheaply made. Supposing the size of aperture to be 12 inches by 8; a zinc box of size sufficient to slide tightly into the aperture should be provided with a lid of zinc, fitted so as to move easily in the inside of this box; the lid should move on a central bar, and be exactly balanced. Fig. 19 will shew at once the nature of its construction; *a a* is the wall, *b b* the valve or lid balanced on the centre *c*. By moving the lid to any required angle, the amount of opening may be regulated. The apertures at the top of the wall may be provided with valves of the same construction, slightly altered as follows; the upper side may have a bar of lead placed in the inside; this will make the valve have a tendency to fall towards the under side; to prevent this, but still to make the movement forcible yet controllable, attach to the centre of the upper side of the lid and outside, a long

Fig. 18.

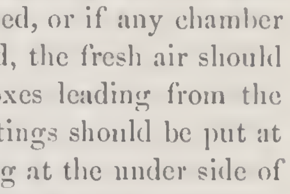


Fig. 19.

bar, having at one end a small cord; this may be fastened to the wall beneath, and loosened or tightened, according as the valve is required to be moved. A variety of valves might be described; but we are of opinion that it is needless to take up room therewith, inasmuch as the architect will have no difficulty in designing any required form.

In supplying fresh air to apartments, it should be carefully borne in mind that *fresh air should never be admitted above the zone of respiration—always beneath it.*

This decided opinion, excluding all openings in windows used for admitting fresh air, disagrees with that of many practitioners, who recommend and adopt " window ventilators" and apertures for the admission of fresh air, placed above the zone of respiration; but in order to arrive at a right understanding on the matter, the following remarks are offered to the reader's consideration. Already it has been shewn that the course of foul heated air is upwards, and that it is forced in that upward ascent, by the pressure or superior density of the cold air beneath; this being the case, there is no utility in admitting cold air to press on the top of a stratum of hot air, or to mix with it. Again, plans for warming the cold air admitted by windows or wall apertures, have been introduced, by which the air is made to project upwards, and mixing with the heated air, is raised in temperature; the cold air thus admitted will certainly be warmed, but then two striking disadvantages will occur; the foul air, being reduced in temperature, by the admixture of the cold air, will also be reduced in ascending velocity, and the cold air (admitted for the purposes of respiration) mixing with the foul air, must of necessity be contaminated thereby. If the desideratum is to supply fresh and pure air to an apartment, it must be useless to admit it in such a way, as that the first operation is to reduce its purity. If the air is to be warmed, proper means are within reach by which it will not be contaminated. The plan of heating cold fresh air, by mixing it with warm contaminated vapour, is as erroneous and contradictory in principle, as it is inelegant in practice. It may be deduced that all window and wall ventilators placed above the zone of respiration are mere " make shifts"; and should be looked upon, at the best, as temporary expedients for overcoming difficulties occasioned by defective arrangements in the original structures.

If other arrangements cannot be made (as in the case of some private apartments) for admitting fresh air below the zone of respiration, whether from local arrangements, or on the score of expense, necessitating the admission of fresh air through the windows, it should be as diffused as possible.

The ventilation of apartments in tropical climates is a matter of considerable importance. In Egypt, a contrivance anciently used for this purpose, consisted of a frame enclosed at the sides, but open at both ends, and divided into two compartments by a partition in the centre—the frame or box not being of the same depth or height throughout its length, but tapered from the ends towards the centre; the roof being thus angular, the wind, entering at the ends, was deflected into the passages beneath. The modern "*mul'ckuf*" is single, and in fact is only a sloping shed erected on the terraces of the houses, with its open mouth directed towards the north or nort-west, to conduct these cooler winds into the corridors below. They are generally made of strong frame-work, filled in with planks; cheaper ones are constructed of reeds or mats, covered with stucco. In India the fan has been used for ventilating purposes from time immemorial; in some cases it is very large, the handle resting on the floor; yet by long practice the native servants have acquired wonderful ease and dexterity in wielding them. The chief effect obtainable by their use is, by giving motion to the air, to project a larger quantity against the body, and abstract therefrom a portion of heat. When a large room is to be ventilated, the contrivance called a punkah is adopted. This is merely a huge oblong fan, suspended in the direction of its length from the roof of the apartment, and moveable from side to side by hinges or suspending cords—a rope is attached to the under side of the fan, and passed through an aperture in the door or wall; by pulling this rope, the attendant is able to communicate a pendulous motion to the punkah, waving it to and fro. Mr. Dobson, some years ago, invented a machine for imparting motion to the air of apartments in tropical climates. A case was suspended from the ceiling over pullies, so that it could be hung at any elevation beneath the ceiling; this case was provided internally with two punkahs or fans, mounted in a frame, and crossing at right angles; rotatory motion was given to these by spring mechanism. By all these contrivances the vitiated air is only agitated, it is not cooled or purified in the slightest degree. Were apertures for the egress of foul air provided, and fanners, screws, or pumps used, injecting fresh air, any degree of pleasant and healthy ventilation would be obtained. As a machine easily worked, from the lightness of its internal mechanism, and as capable of throwing in any quantity of air, Arnott's pump (above described) would be eligible for ventilating apartments in tropical climates. The difference between the temperature of the air in apartments, and that of the external atmosphere in tropical climates being slight, the mere providing of exit and egress apertures, would probably not suffice to create that sufficiently rapid current of air, which the inhabitants of those countries consider so essential to health and comfort. By the use of a well devised system of egress apertures, and an efficient pump, the ventilation of any apartment would be easily attainable; the heat of the air sent in might be lessened, by passing it over cooling chemical mixtures, or through water. By having a simple arrangement of fly-wheel and crank, the power of a man could work—for many hours a day—a sufficiently large pump to supply a suite of apartments with a due amount of fresh and pure air. It is worthy of notice, that Professor Smyth has developed the construction of an apparatus for so compressing the air, that it shall enter the room at a considerable number of degrees below the temperature of the external air. A one horse-power machine "may be expected to furnish a room with about eighty cubic feet of air per minute, cooled 15° to 20° below the atmosphere outside. The room to be filled with cooled air, should either be surrounded by a wall, unbroken by doors and windows, to at least four feet in height; or, which would be the better plan, should be sunk that, or a greater depth, in the ground." The machine is fully described, and illustrated with a diagram of the apparatus, in the CIVIL ENGINEER'S AND ARCHITECT'S JOURNAL, vol. xiii, p. 300.

The most efficient mode of carrying away foul air will be to make apertures, of sufficient numbers and size, in the interior ceiling, or roof (if there be no ceiling); leading the air up by means of ventiducts to the external atmosphere. In cases where there is an inner space between the roof and ceiling, the vitiated air should be led through it in the ventiducts, and not by any means be allowed to spread in the empty space. The external air is always cooler than the vitiated air to be withdrawn from the building; that contained in the roof is cooler also, and, acting upon the vitiated air, reduces its temperature, and causes descending currents. No one, while wishing to withdraw water from one space, would allow it to spread itself over another, but would at once confine it in the appointed tubes: so in like manner it is wisest to withdraw vitiated air at once, and not allow it to spread itself in large spaces.

The vitiated air ventiducts should project some space above the ridge of the external roof, and be carefully finished at top, as will be seen in subsequent observations. They can be made most conveniently of wood, and should be air-tight. Valves should be provided in the interior, to regulate the egress of the air. The following is a sketch and description of one. At any convenient place near the entrance of the ventiduct, is put a valve, working on a central bar, *c*. When horizontal, it should be of sufficient size to fit the area of the ventiduct. At one side *b* it has a heavy weight or counterpoise firmly attached; to this fix a rope, chain, or cord, *d*, passing through a hole in

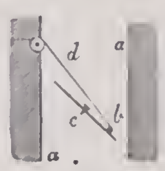


Fig. 20.

the side of the ventiduct over a pully fixed in a bracket, fastened on the outside, along the space of the roof to the wall; entering finally into the interior of the building through an aperture in the ceiling, and continued to any part of the interior required. At the place where the cord passes down to the inside, another pully should be fixed, over which the cord should run. To counterbalance the weight fixed in the valve, another should be suspended from the end of the cord in the interior. This weight could be made ornamental, and have a pointer projecting from its end or side. The weight should slide up and down between two upright slides, made of wood or metal, fastened to the front of a decorated board. On this board an index-plate should be fixed, having the words Open, Shut, Half, etc., painted thereon, at distances corresponding to the opening or shutting of the valve. The adjustment of the plate will be a matter of no difficulty. When properly adjusted, the pointer of the counterbalance weight at the end of the cord attached to the valve, should, when the valve in the ventiduct is shut, point to the word Shut, and so on. In fig. 20, *a a* is the ventiduct, *b* the weighted valve working on the centre *c*, *d* the rope or cord for working the valve. If open holes be objected to in the ceiling, pendants suspended some ten or eighteen inches beneath the opening, will mask the apertures completely. They should be carefully fastened by strong iron bars. The under parts of these pendants may be made highly ornamental. The air will pass round the upper edges, and enter the aperture of the ventiduct above. The opening, if left open (without the pendant), would have a tendency to draw away the column of air only immediately under it; while, by means of this pendant, the air is drawn horizontally, as it were, creating a horizontal current calculated to draw off the whole air near the ceiling. The diameter of the pendant should therefore be somewhat larger than that of the opening of the ventiduct.

Having mentioned that the ventiducts should be carefully finished at top, it remains to say that the contrivances used for this purpose are numerous. The moveable or revolving cowl or cap seems to be most used; but there are serious objections to this plan in public buildings. However well constructed, it invariably makes a noise, which is heard in the building below; moreover, like all moveable constructions, it is liable to get out of order; its efficacy being in such an event completely impaired. Stationary tops are therefore preferable. The desiderata for all such contrivances are, means of obviating down-draughts, and the descent of rain, snow, etc., and facility for admitting the egress of the foul air. An excellent top, shewn at *c*, Fig. 21, recommended by Tredgold (*Principles of Warming and Ventilation*, 8vo, Lond. 1836, p. 92), has been largely used: the stronger the wind blows, in passing over this top, the more it causes an upward current in the ventiduct, materially assisting the natural ascent. *a* is the top, to prevent rain etc. from falling down the tube; it is here shewn flat, and only held in the pot by three legs, differing in these respects from Tredgold's, according to the improvements adopted by the late Mr. Papworth, which allow of its regulating the quantity of open space, and if pushed off by accidental means, a chain of sufficient length prevents its hurting the roof.

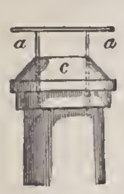


Fig. 21.

The common louvre-shaped openings may, if constructed well, be useful to a certain extent; if they could be used circular, they would answer better. These and the top above described, can be covered on the outside by ornamental boxes, corresponding with the style of architecture of the building on which they are placed, made in such a manner as not to impair their efficiency. The best mode of doing this will at once occur to the architect. The patented top of Mr. Kite of London, which he calls the "Diamond Deflecting Top", is constructed on truly philosophical principles.

Where the use of the ventiducts in the ceiling and roof is not approved of, the vitiated air may be withdrawn from the interior of public buildings by means of apertures in the wall, near the ceiling, communicating with flues in passages made in the interior of the walls. The apertures for the egress of the air should be beneath the eaves, or cornice at the top of walls, and be carefully covered with bars of iron, iron wire, or zinc work, to prevent birds from entering, and building their nests in the flues. The apertures in the interior, for the admission of foul air to these flues, should be masked with ornamental work, and should be provided with valves, similar to those described, for the fresh-air ventiducts, when the entrance aperture is at the top of the wall, as at fig. 19. The apertures for the egress of the foul air may be made to communicate with the space between the ceiling and the roof, and finally withdrawn therefrom, by a ventiduct placed in the turret or spire, if there is one in the building to be ventilated. If there are galleries in the interior, as the foul air from the parts immediately beneath is apt to stagnate beneath them, ventiducts having their apertures in the wall, just beneath the floor, should be made, to draw off the foul air.

These modes of withdrawing the foul air, just mentioned, will not, and cannot, be so effectual in their operation, as the method first described, when the foul air is led off at once, from the highest part of the ceiling, through ventiducts vertically placed. Heated air to be drawn in horizontal or lateral currents, or in any other way, save vertically, requires some controlling force; on the contrary, when withdrawn vertically at once from the place in which it is produced, the fullest advantage is taken of the natural laws which regulate its movement. Heated air should always be confined in the spaces made for its egress, of a size sufficient to contain the requisite quantity, and should never be allowed to spread itself among large spaces, where, cooling, its ascending power is totally destroyed, or at least very materially diminished. These are points very necessary to be recollected, and observed in practice.

In ventilating the apartments of private dwelling houses, care should be taken to give each room an independent supply of fresh air. This may be done by making apertures in the walls, communicating with the space behind the skirting board, which should be pierced full of small holes; or sheets of perforated zinc may be substituted for boards. The architect will at once perceive that the means to be adopted for admitting fresh air to apartments will be various, and greatly dependant upon local circumstances; the principles, however, being in all cases the same. The foul air may be withdrawn by ventiducts made in the walls, communicating with the interior of the apartments by apertures placed behind or above the cornice; or from a central opening in the ceiling, as already described; or one of the chimney ventilators may be used. In ventiducts made in the walls, the apertures for the egress of the foul air may be beneath the eaves, or be led by boxes or pipes to a ventiduct placed at the highest part of the roof.

If the various apartments have free connexion with a central staircase, or corridor surmounted by a skylight, the foul air may be withdrawn from each apartment, by having above each doorway, or at the top of the wall or partition dividing the room from the staircase or corridor, an aperture for the egress of the foul air, which will escape therefrom to the staircase; whence it may be withdrawn by a ventiduct placed at the highest part of the skylight. As the cooling surface of the glass will materially reduce the temperature of the air, the skylight should be made with double glass frames. If the corridors and central staircase in a large dwelling house be well supplied with fresh air, each apartment may draw its supply of air therefrom, through apertures made for the purpose of admitting it; the foul air being withdrawn by any of the means previously described. It is, however, most desirable that each apartment should have an independent source of supply; an advantage too obvious to require elaborate explanations.

The rule for finding the area of foul and fresh air apertures proportioned to the number of people the apartment or building is to contain, is the next point for consideration. The quantity of air required per minute for each individual has been variously

estimated. Tredgold makes it four cubic feet; Arnott, five; and Reid, ten. From an examination of the deductions made by the first in order of these authorities, four cubic feet seem to be amply sufficient for each individual per minute; but the practitioner will of course vary the multiplier, in the following rule deduced by Tredgold from his experiments, according to the amount allowed. "The most difficult season for ventilation," says Tredgold, "is the summer; and we may consider that there should not be a greater difference in warm weather than ten degrees; and with this limit as to variation of temperature, we shall have the following rule: *Multiply the number of people the room is to contain by four, and divide this product by forty-three times the square root of the height of the tubes in feet; and the quotient is the area of the ventilator tube or tubes in feet.* By the height of the tubes, is to be understood the height from the floor of the room to the place where the air escapes to the atmosphere; and they must be all of the same height, if there are more than one." This point is carefully noted, as otherwise the taller would overpower the shorter tubes. The area of foul air aperture should be distributed over the roof in more than one place: thus if three square feet of aperture were required, instead of making one opening of three square feet in area, it would be better to have three of one square foot each. The size of the aperture for the admission of fresh air may generally be of the same area as that for the egress of the vitiated atmosphere. If tubes are led, say from the apertures in the exterior wall, to the passages in the centre of the building, then they should be of the same area as the foul-air ventiducts; but if mere simple openings are made in the outside walls, then double the area will be required. Tredgold (*Principles of Warming*, pp. 76-92) recommends these alterations in size to be made, on account of the fresh air being required in large volume. A tube will accelerate the velocity passed through an aperture, delivering more air in the same time, than will a simple opening; there will, however, be more of a rush with the tubes, than with the large opening.

In these remarks, unnecessary elaboration has been studiously avoided: yet it has been endeavoured to point out clearly the essential requisites for efficient plans of ventilation. In accordance with the arrangements adopted, the various plans generally used are here explained; and if the reader has carefully attended to these explanations, he will have no difficulty in thoroughly ventilating any place, whether the plans may belong to a distinct division, or be dependent for their operation upon a mixture of them all—that is to say, by exclusive fires, machinery, or natural currents, or partly fire-draught, and partly machinery and natural currents.

With reference to the merits of these three modes of ventilating, it is sufficiently obvious that all arrangements depending upon extraneous superintendence and care, must necessarily incur the chance of being neglected. Where a fire is to be maintained, or a machine to be superintended, the chance is that at some period or other they may be overlooked; and when constant and careful attendance is not given, the operation will be varying, inconstant, and consequently defective. Again, the expense of keeping up exclusive fires, or furnaces, or machines, is likewise to be considered; as the power must be kept up so long as ventilation is required, the expense will also be continual. Moreover, the original expense in constructing and fitting up is considerable, and machines require to be kept in good working order.

On the other hand, where advantage is taken of simple unvarying laws of nature, which are always in action, the arrangement dependant upon them will be invariably maintained; and therefore, in all cases, where the nature of the building will admit of it, only natural Ventilation should be adopted.

A writer on this subject, in passing severe strictures on builders, for endeavouring as much as possible to meet the demands of their employers, by tightly closing up every aperture through which air can gain admittance to dwelling-houses, says: "that luckily, in spite of all their endeavours, their close fitting doors and windows, air still finds access." And so it does: the laws founded for a benevolent purpose will act, however much man may retard and oppose them. Is it not consistent then, with natural laws, to suppose that if air forces itself into apartments, when every means are taken to exclude, and when once in to confine it; that surely it will gain easier admittance when apertures are formed to facilitate its admittance when pure, and, when deteriorated, to allow it likewise to escape? Yet many strenuously advocate the use of machinery more or less complex, in almost all cases where ventilation is required; as if it were an absolute impossibility to supply air without such mechanical appliances.

Reid says, that the ascent of air in shafts, at the ceiling, acts in *all cases* where the density of the air within is less than that of the air without. This opinion is amply corroborated by the result of every opportunity of experience. The cases will be very rare indeed, wherein the conditions above implied will not be found to exist; for in winter, the heated air in the interior is sure to be of less specific gravity than the cold air in the exterior; and even in summer, although the heat of the breath in the interior, and that of the air on the exterior of the building, may be nearer in equality than in colder weather, there is, and must be, a decided difference in favour of that in the interior. This is amply proved, when the fact is considered, that it is much hotter in a crowded building than in the open air, however calm, in a hot summer day; the heat of the bodies, in a certain degree raised in temperature in proportion to the number of people assembled, and the concentration of the heat by confinement, all tend to the result found.

Not only can buildings be ventilated efficiently by the adoption of the laws in constant action, but, what is of considerable importance, the expense of so doing is comparatively trifling; moreover, when once effected, repairs are not required, neither is the expenditure of any expensive power necessary to maintain its operations. Again, there are no complicated arrangements difficult to be understood by that class who, in all public buildings, will generally be found to have their management.

To recapitulate very briefly,—the essential requisites of efficient ventilating arrangements are,—apertures for the admission of fresh air and the egress of the vitiated; (these acting in unison with each other). The fresh air to be always admitted below the zone of respiration, never above; the more the fresh air is diffused, the less palpable will be the currents; the smaller the apertures through which it passes, the better will be the diffusion. Advantage should always be taken of any casual power of fire-draught, taking care to have the air-flues connected with the chimney or furnace, as smooth as possible, and the curves easy. In descending currents there is always a loss of power in using a "gas rarefier", hot-water pipes, or steam jets; therefore, they should be placed at the highest part of the building. Foul air should never be allowed to spread itself in large spaces beneath cold roofs; but in using ventiducts, it should be led off at once to the external atmosphere; the top of the ventiduct being carefully finished at top.

In considering the necessity of incorporating with the original plans arrangements for ventilation, the architect will perceive that the expense will thus be greatly lessened, and the facilities for introducing efficient plans considerably increased. The subject "can never be placed on the most desirable footing, until the principles of ventilation are made a subject of primary, instead of secondary consideration, in all structural arrangements; otherwise, the means of economic ventilation may too often be considered as superseded, before any attention has been bestowed upon them.

"It is no exaggeration to say, that along with those means of defence and seclusion which it naturally presents, the great and primary object of architecture is to afford the power of sustaining an artificial atmosphere, such as the constitution under each variety of local circumstances may require. It is in reality

to every building, what the breath of life is to the human frame—the vivifying principle, without which they would be tenantless and uninhabitable." (REID's *Illustrations*, p. 71.) One very important benefit to be derived from the ventilation of architectural structures will be the admission of fresh air to the beams; this will prove a valuable antidote to the dry rot, by removing that moisture, carbonic acid, and insensible exhalations of animal matter, which form the great food of this disease in non-ventilated apartments.

Ventilation, where at all adopted, has been generally confined to public buildings; nevertheless, while urging with all earnestness the supply of pure air to such places, it should not be forgotten, that the art will not become really useful until it has been applied to the improvement of the dwelling-houses of the vast body of the people. It should be looked upon alike by the professional man and the philanthropist as highly useful for the attainment of benevolent ends, to be used for the benefit of the many, not to be confined to the attainment of comfort for the few. As a remedial measure, ventilation is of the highest importance. What have been long known as "national diseases", are incontestably proved to be caused almost solely by the effects of impure air. Consumption, scrofula, and a host of minor maladies, if not entirely owing to this cause, are by it wonderfully aggravated in their effects, and rendered more fatal. The deadly typhus owes its malignance to defective ventilation.

No particular building, and no peculiar modification of any system, has been selected for especial consideration herein, as there is unfortunately scarcely any instance to be found, in which the conditions of the case are precisely similar to those likely again to occur to the practical man; nor is there, as yet, a sufficient number of instances of perfect success obtained, by what may be termed, without any invidious meaning, empirical inventions. No one plan or system, however successful in some particular case, can possibly be applied indiscriminately to all; the principles and rationale of ventilation are simple and unvarying; not so the modes of their adaptation: these, in the extensive practice of the professional man, are as numerous as they are varied. It is, then, for those, who wish to effect good ventilation in structural arrangements, to study well the principles, in order to meet the difficulties which will arise, and so as to carry them into successful operation.

In working out efficient plans, architects have much in their power; indeed, with them rests almost solely the practical adoption of the best systems. It is obvious that good plans are more economical than ineffective arrangements; and, in the case of original buildings with ventilating arrangements primarily incorporated, the expense may be considerably lessened. It is for the architect then, with or without the demand of his client, to propose to adopt arrangements for securing a full and constant supply of fresh air to all edifices, whether public or private, designed for the occasional or permanent use of man.

ROBERT S. BURN.

Of the numerous publications upon this subject, the following works may be particularly mentioned:

History of Warming and Ventilating, by WALTER BERNAN; TREDGOLD'S *Principles of Warming and Ventilating, with Appendix to Ditto*, by J. BRAMAH, 1833; HOOD'S *Warming and Ventilating*, 1844; REID'S *Illustrations of Ventilation*, 1843; ARNOTT'S *Treatise on Ventilation*, 1838; RICHARDSON'S *Treatise on the Warming and Ventilation of Buildings*, Second Edition, 1839; AINGER'S *Ventilation and Warming*, 1835; ALEXANDER'S *Observations on the construction and fitting up of Meeting Houses, etc.*, York, 1820; WALKER'S *Useful Hints on Ventilation*, London, 1850; URE on Ventilation, in *Supplement to Dictionary of Arts and Manufacture*; BURN'S *Practical Ventilation*, 1850; *Report on the Sanitary Condition of the Labouring Population in Great Britain*, by EDWIN CHADWICK, 1842; *First Report of the Health of Towns' Commission on the State of Large Towns and Populous Districts*, 1844; *Second Report on ditto*, 1845; *Sanitary Economy*, W. and R. CHAMBERS, 1850; *Sanitary Movement*, CHAMBERS' *Papers for the People*; *On the Uses and Abuses of Air*, by DR. JOHN GRISCOM, New York; *Warming and Ventilation* (CHAMBERS' *Information*, 1841); INMAN'S *Report of the Committee of the House of Commons, on Ventilating, Warming, and the Transmission of Sound*, with notes, 1836.

EXTRACTS FROM THE

PRINCIPLES OF WARMING AND VENTILATING PUBLIC BUILDINGS, ETC.

BY THE LATE THOMAS TREDGOLD.

Third Edition. 8vo. London: 1836.

§ 75. If the impure air be to escape in consequence of its own levity and elevated temperature, which in this case will be sufficient, it should be through tubes of uniform diameter, for every enlargement produces eddies, and interrupts the discharge of the air. Each tube should be independent; for if currents be let into the same tube from different apertures, they will cross each other, and interrupt the flow of air. The tubes of rooms on the same level, which communicate with one another, should all be taken to the same height, otherwise cold air will blow down some of them; and if this does not happen, the effect of the lower tubes will be less than that of the others.

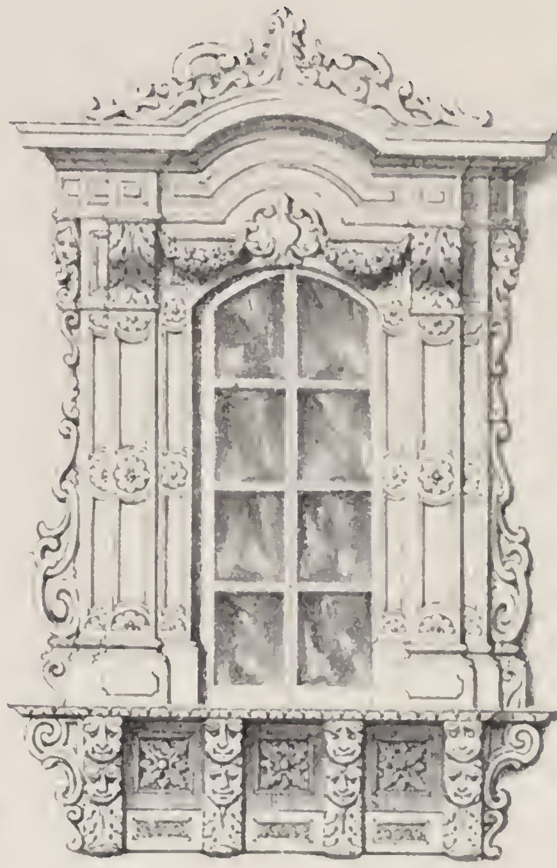
An open fire with a chimney in a ward is inadmissible with this mode of ventilation, and will completely stop it; for a current of cold air will either come down the ventilating tube, or the room will smoke.

But several tubes from the same level may be opened into one common top with advantage, and this top, whether for single or other tubes, should be either moveable, or the top shewn in Fig. 21 may often be employed with advantage.

The area of tubes should never be greater than is wanted for the extreme quantity of ventilation; for a tube that is larger than necessary, will either allow a double current, or the rising current will be retarded by eddies.

§ 138. Ventilation is most difficult to maintain in close, still, gloomy weather. Suppose we wish to provide ventilation sufficient to prevent the internal air from being of a higher temper-

WINDOW



BENEDICTINE CONVENT

STADIA DEGLI QUATTRO CANTONI

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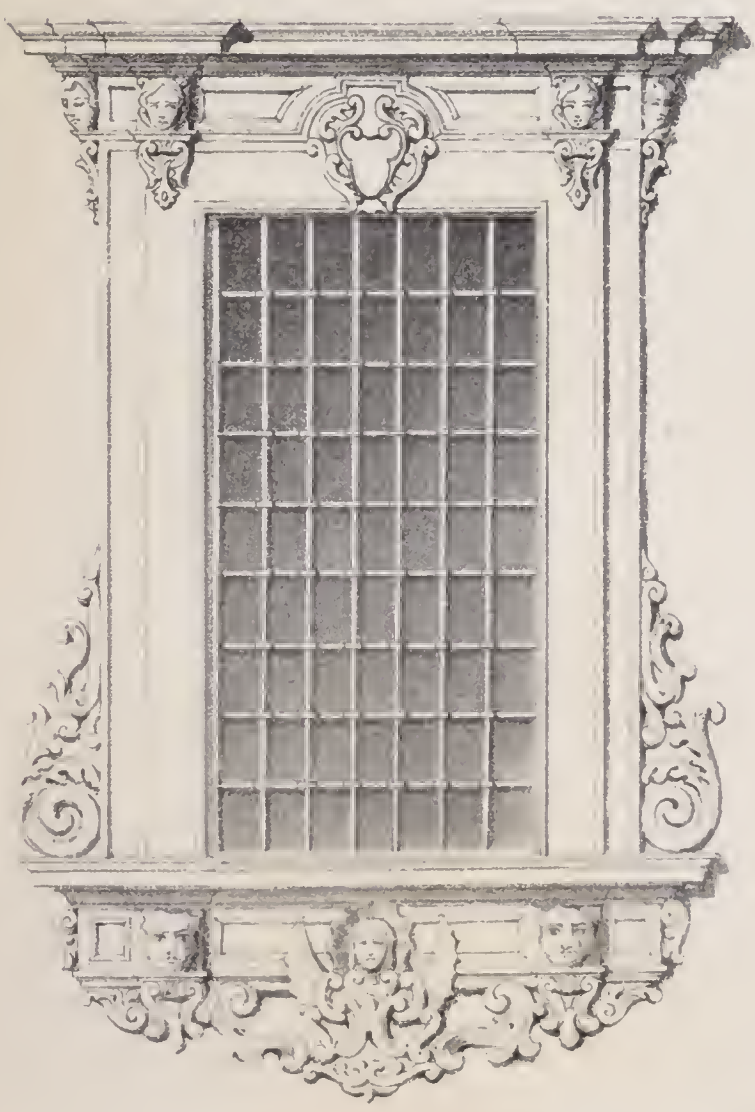

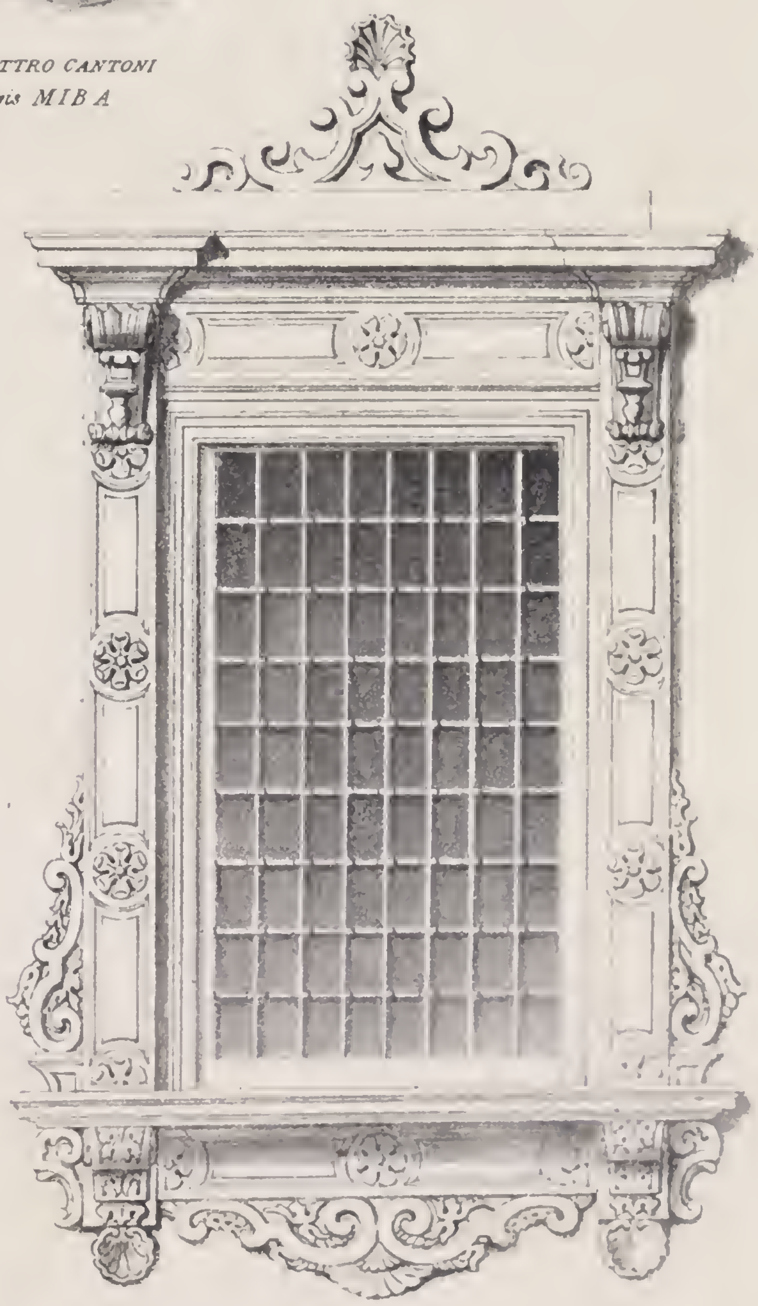

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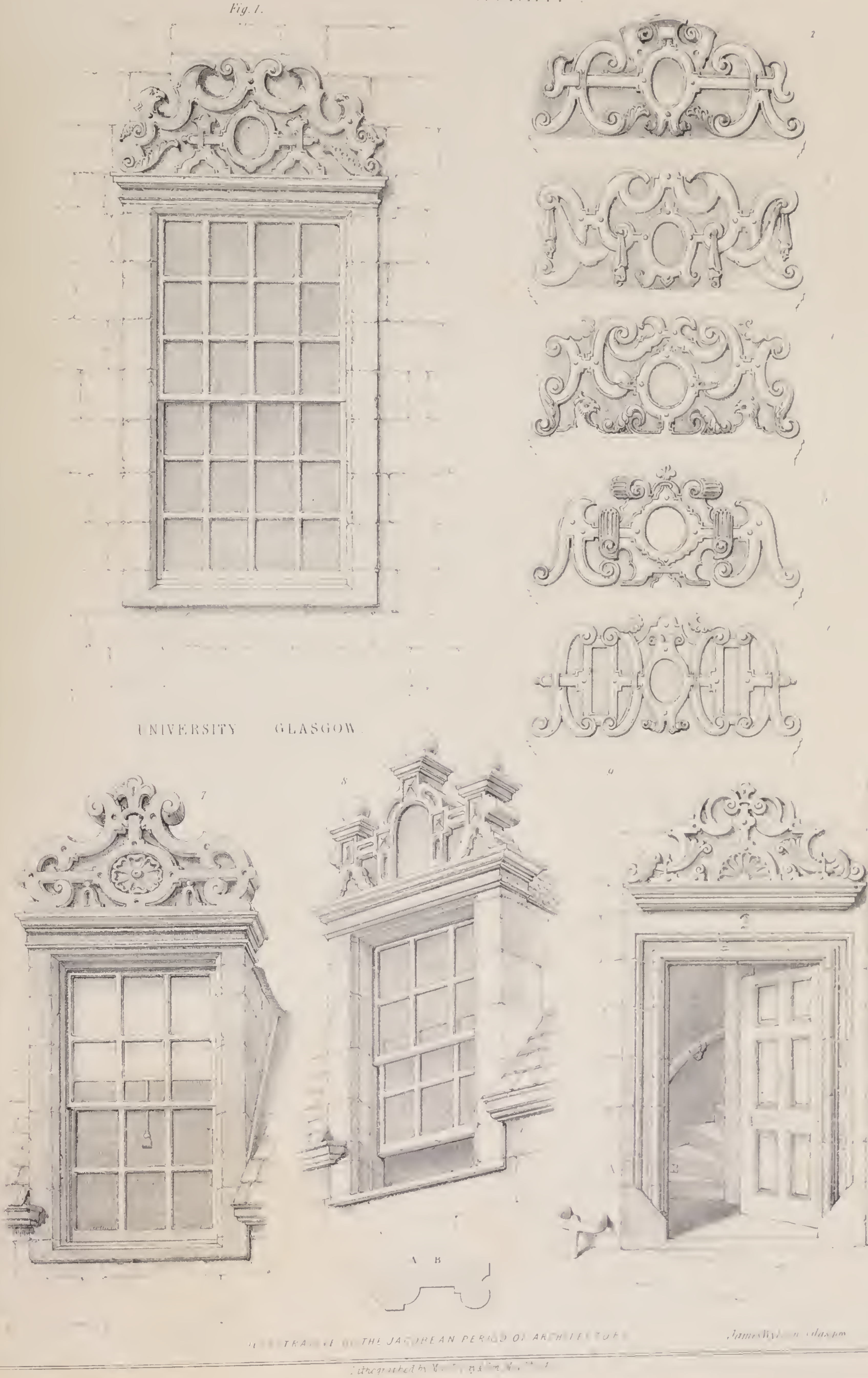
CATANIA

BENEDICTINE CONVENT

WINDOW CORONETS.



ILLUSTRATIVE OF THE JACOBEAN PERIOD OF ARCHITECTURE. James Wyl[illegible]

Lithographed by [illegible]

WOODWORK.

CARVED WORK ON BENCHES.
S^T MARY'S CHURCH.
LUBECK.

L. Gruner

Printed by Hullmandel & Walton

ARCHITECTURAL PUBLICATION SOCIETY.

DESCRIPTION OF ILLUSTRATIONS

CONTAINED IN THE FIRST TWO PARTS OF THE VOLUME FOR THE YEAR 1848–1849

It should be premised that these Illustrations are expected to form the graphic portions of those articles, which will have the same name or title, and thus a great step has been made towards the commencement of a Dictionary, without waiting for the natural course of the text to which they relate. Under whatever circumstances these Plates may come into the hands of the Architect or Amateur, whether with text or without any more than mere description of position, date, &c., they will certainly be of the very greatest value; not so much that nearly the whole of the specimens presented have not before been published, as that they are carefully selected for their intrinsic merit.

It is satisfactory to be assured that already some ideas, traced in these works, have been made useful, without servile copyism, by those who have had the skill to see the worth of their suggestions.

The little that is needed to be said of each example will find its natural arrangement, by the name or title of the Subject, under which all the Plates are here grouped together.

CAMPANILE.

(Plates I., II., XIII., XIV., and XV.)

The four most celebrated towers in Italy are those of Pisa (called the Leaning Tower), of Florence, of Modena (called the Ghirlandina, from the bronze garland which surrounds the weathercock), and that called the Torazzo or Toraccio, which, from the boldness displayed in its design, and the height to which it was carried, has obtained for Cremona its architectural celebrity. It is said to have been carried up to the top of the square part in the space of two years, and is the highest of all the towers in the north of Italy, reaching the elevation of 396 feet. Four hundred and ninety-eight steps conduct to its summit. Of the whole height, 264 feet is given to the square part, which is six diameters high. This is divided into seven stories, by cornices or string-courses of intersecting arches, and the three upper ones are lightened by apertures with columns and pointed arches. Above the square tower are two octangular stories, gathered in to support a pyramid, the whole so graduating that it partakes of the character of a spire. Great skill is displayed in the construction of the upper octagon, or rather monopteral temple of sixteen small columns, on which the surmounting pyramid is placed. Two staircases, contained in the thickness of the walls, lighten the structure without destroying its durability, and four others lead from the last story to the summit.

We have been unable to discover the name of the architect, or dates, with certainty.

Of the fourteen later examples contributed by Mr. John Johnson, a division into two groups will easily be made, *i. e.*, *a*, of those with a tall basement and decorated head (Pl. I. Fig. 2, Pl. II. Fig. 3, Pl. XIV. Figs. 1 and 3); *b*, of those in stages, in which the remainder are included, having indifferently string-courses or entablatures, (in some cases with orders.) The idea of this latter group seems closely allied to that of the belfry built by Adrian I. to the church of Sta. Francesca Romana, which became the model for most of those of the ancient churches of Rome. They are all square towers of brick, plain up to the height of the principal roof which runs against them, and afterwards divided into stories by projecting cornices; each story has a greater, or less, number of windows, divided by single pillars. Medallions of different kinds of marbles, and sometimes of terracotta, are let into the walls of these towers as ornaments; and at the summit, immediately under the eaves, there is sometimes a corbelled projecting niche, for an image of the Virgin. Of this class is the Campanile of Sta. Maria in Cosmedin at Rome, of the eighth century. See Pl. XV.

It will be remarked that the windows increase, at each story, in an ascending series—an arrangement frequently to be observed in the towers of Italy.

Can information be given on any of these points, the architects, &c.?

CEILINGS.

(Plate III.)

The Chiesa Gesù at Rome is said to have been the work of Vignola, so far as relates to the interior.

The Palazzo Braschi at Rome was built by a nephew of Pius VI., both of that name, from the designs of Morelli.

The Teatro Canobiana at Milan (information requested).

CHIMNEY.

(PLATES IV. and XVI.)

Those examples from Genoa are the types usually met with in that city; another form is the Fig. 13, with a *cima recta*, the top still being wider than the bottom, and the flat face being often ornamented in relief. Those from Venice are, probably, variations of a simple form, like those given as designed by Palladio, all the nine forms being now usual in the north of Italy. Three principles seem to be displayed herein, viz. *a*, those with open tops, and artificially contrived up-draughts, of which two sections are given in Pl. IV.; *b*, those with closed tops, and orifices in sides, as if to obviate effects of down-currents; and *c*, those, like Palladio's, designed on the principle of the shape of a funnel, at the angles fittest for the most rapid emission of water.

The examples, Pl. XVI. Figs. 8 and 13, were from the convent of Sta. Giulia at Brescia, and with that from a church near Saint Lo in Brittany, afford very desirable hints for such appendages in similar cases.

CORBEL.

(PLATE V.)

Figs. 1 and 2 give a corbel, &c. from the ceiling of a bed-room in an old palace at Verona, now the Albergo delle due Spade. The beams (about 20 feet bearing), of which there are two remaining, rest at each end on profiled wooden corbels, supported by stone brackets, and are richly ornamented, both with carving and colour, the ground of the tracery being painted black. The spaces between the small blocks beneath the panelling are alternately blue and red, diagonally. The spaces between the dentils on the face of the wooden corbel are similarly decorated. The beams are about 16 inches by 9 inches, and the cross-beams 12 inches by 6 inches, of a dark wood. They date about 1360–1380. Since this plate was issued a similar ceiling has been published by Gruner.—(*Ornamental Designs for Decoration and Manufactures, published under the authority of the Council of the Government School of Design, Part* iii.)

The same form of corbel, as that from the Corte delle Muneghe at Venice, is found in the upper loggia of the Doge's palace, facing the Piazzetta, and is apparently of the middle or end of the fourteenth century.

The beams of the roof of the church of S. Francesco, at Pisa, are supported upon corbels, three examples of which are here given. The other specimens from Pisa and Pistoia shew elegant examples of corbelled eaves. Dates?

The Plate No. XX. of metal work also contains three good ideas of corbels.

CORNICE (BRICK).

(PLATE XVII.)

Figs. 1, 2, and 5 from Rome have stone corbels introduced, whereas No. 3 from Ferrara, and No. 7 from Bologna, are of terra-cotta.

Fig. 4 is a brick cornice from the church of the Servites, at Bologna, built by Fra Andrea Manfredi of Faenza, architect, and general of the order, in 1392. The eaves of the roof come immediately over the upper course of bricks.

Fig. 5 is from the great hospital at Milan, said to be built in 1456, from the plans of Antonio Averrulino, and afterwards enlarged in a newer style (TSCHISCHKA, *Kunst*, &c.); but ascribed by VASARI (who gives the date of laying the foundation-stone, 12th April, 1457) to Antonio Filarete of Florence, (*Vite, in nom.*)

Fig. 6 is from Santo Stefano, Venice, a gothic building of the year 1325, also introducing terra-cotta. The peculiar billet-moulding (with splayed edges) is common to the north of Italy, and is generally employed as the outer moulding in architraves of doors.

CORTILE.

(PLATE VI.)

This celebrated design was executed by Vignola for Cardinal Alessandro Farnese, before 1573. It forms the centre of the chateau of Caprarola, near Viterbo, and is 70 feet in diameter. It is sufficient of this size, the building having but two floors, so that it only serves to give light to two circular loggie, one over the other, and each 13 feet wide. On the top of the pedestals, in engravings of this work, were formerly represented statues, which are now wanting.

DIAPER.

(PLATE VII.)

The originals are from the walls of the upper church of S. Francesco at Assisi. The church was commenced, in 1228, by a German architect, Jacopo di Lapo; and finished in two years. Cimabue painted the vaulting and the upper range of the frescoes on the walls of the nave. The lower range of paintings was executed by the school of Cimabue and Giotto. Beneath these decorations, and above a stone seat running the whole length of the nave, are these diapers, painted in imitation of tapestry; such diapers of this period are very rarely met with in Italy. They must be of the epoch 1350–1370; as amongst numberless names, versicles, texts, &c., scratched upon them, many in gothic characters occur, frequently dated in the early part of the fifteenth century, and one as early as 1383.

As example of arrangement of colours, it may be said of Fig. 2, that the centre ornaments, and the double circles between them, are produced by pale red on a dark red ground; the parts immediately above and below these circles are white on yellow; whilst the ground of the cross is purple, with white cinquefoils and quatrefoil in the centre.

In Fig. 3, green replaces the white upon the corresponding yellow ground, and a green ground with white is used in lieu of purple and white; it will be seen that the lower pattern is similar to the centre one in arrangement, the circular lines being changed into rectangular forms. The execution is free, and rather coarse.

DOORWAY.

(PLATE XVIII.)

Philippo Vastavillano, of Bologna, nephew of Pope Gregory XIII., created in 1574 Cardinal Deacon of Sta. Maria in Cosmedin at Rome, between 1578 and his death in 1587 repaired the ecclesiastical buildings in Loreto at immense cost; and the inscription, on the frieze of this magnificent portone, is

· PHILIPPO · CARDINALE ·
· VASTAVILLANO ·
· PROTETTORE ·

Giuliano di San Gallo is considered to have been the architect, and, if so, this doorway must be anterior to the cardinal's repairs.

The opening is 9 feet 4 inches wide by 22 feet 11¾ inches high, and slightly diminishes upwards.

FAÇADE.

(PLATES VIII. and XIX.)

A more ornamental style of exterior decoration than has been usually attempted in this country, is suggested by these designs, which would be very effective if applied to brick fronts, now generally left plain.

The remarkable feature in this style is, that while the gothic tracery of the trefoiled heads is retained, instead of allowing that foliated work with its cusps to form the outlines of the apertures, it is worked on the solid part. This is a most judicious arrangement, as it preserves the more ornamental portion from liability to injury and destruction.

LOGGIA.

(Plate IX.)

The cathedral at Spoleto was built about 1067, but this exquisite loggia, the work of Bramante, was attached to its front in the latter part of the fifteenth century.

METAL WORK.

(Plate XX.)

Figs. 1 and 2. These fine bronze rings and ornaments, probably intended as supporters of standards, were doubtless executed, as Fig. 3, the cresset (from the same Palazzo Strozzi at Florence), is known to have been, by Nicolo Grosso Caparra, whose name arose from the heavy retaining fees which he demanded.

Vasari (*Vita di Cronaca Fiorentino*) is charmed with these specimens of his handiwork, and calls them "Lumieri maravigliosi."

Figs. 4 and 5 were cast by —— Mazzini and Jacopo Cozzarelli for the Palazzo del Magnifico, which is remarkable as having been erected in 1504 by Pandolfo Petrucci, the celebrated tyrant of Sienna. (Vasari, *Vita di Francesco di Georgio.*)

Their size is about 2 feet 6 inches in height.

PAVEMENT (MOSAIC AND INLAID).

(Plates X. and XXI.)

Figs. 1 and 8 are Mosaics, from Pompeii, in the Street of the Silversmiths. Fig. 1 forms the centre of the pavement of the Triclinium; such was probably Fig. 3, which, with Figs. 5 and 13, were all found in one house near the city walls. Fig. 4 is from a house near the Gate of Herculaneum, as is also Fig. 6, of which the centre is, in the original, filled by a helmet.

Fig. 10 is also from Pompeii, as are Figs. 7, 9, 11, from houses excavated by General Championnet, in the street south of the Basilica; Figs. 2, 7, and 9, form the thresholds of doors.

Figs. 12 and 14 are pavements now in the Braccio Nuovo (Vatican), found in the excavations at Tor-Marancio, outside the Porta San Sebastiano.

The scales are in the following proportions to a foot. Fig. 1 is $\frac{3}{4}$ inch, Fig. 3 is $\frac{15}{32}$ inch, Figs. 10, 12, 14, are $\frac{1}{4}$ inch, and Figs. 4, 5, 6, 7, 8, 9, 11, 15, are $\frac{3}{8}$ inch.

Plate XXI. Figs. 1 and 2. From the Baptistery, Florence. This style of inlaid pavement is peculiar to Tuscany; Lucca, Florence, Pisa, Pistoia, and Sienna, abounding in rich examples of the effect produced by incisions in white marble slabs, filled with black or very dark green marble or cement. The pavement of the Duomo at Sienna is the most celebrated work of this class. That in the baptistery at Florence was most probably done, in 1288–1293, under Arnolfo di Lapo, when he coated the exterior of the building, with black and white marble ashlaring.

Figs. 4, 5, 6, 7, 8, and 9, from San Miniato, Florence. The pavement of this church, of the same species, is remarkable for the variety in the patterns, the quaint ornaments introduced in the centre compartments particularly attracting attention: amongst other subjects a zodiac is represented. It probably dates from the eleventh century.

Fig. 3, from the Duomo, at Lucca, dates from 1308, when the church was lengthened and raised.

STAINED GLASS.

(Plate XXII.)

The importance of the occasion on which the Church of San Francesco at Assisi was constructed was such as to make it certain that those, who were concerned in the undertaking, would endeavour to make it a remarkable work. This edifice was built to receive the mortal remains of the great St. Francis, the year after his canonization, which took place in 1228, two years after his death, and is a purely German work.

The stained glass, executed by Fra Francesco di Terranovo, in 1476, and completed by Ludovico da Udine, in 1485, was presented by Sixtus IV. to the church. The upper design is particularly rich in effect, and both are valuable to the student.

The windows have mouldings, but no tracery. The walls are covered with frescoes. The ceiling is spangled with stars of gold upon a ground of turquoise blue, alternately with pictured compartments. The stalls are of beautiful woodwork, inlaid with a variety of figures and patterns.

STAIRCASE.

(Plates XI., XII., and XXIII.)

Plate XI. Fig. 1, is from the cortile of the finest baronial castle in Italy, built of black volcanic stone, with four lofty towers, by the Orsini at Bracciano, about twenty-four miles from Rome, in the fifteenth century, of which period, and of the mixtures of styles prevalent at its close, this staircase is a very good example.

Figs. 2 and 3, with their details, are excellent specimens of the unassuming attention to utility, without unnecessary ornamental construction, which so eminently gives the appearance of originality to the works of our predecessors.

Plate XII. is an example of an ingenuity of adaptation of plan, &c. to incongruous circumstances, which has had a very felicitous result, as shewing what can be done by a judicious arrangement of architectural decoration, in connection with the results of a prescribed mode of obtaining chiar'oscuro.

Plate XXIII. It would give a very useful lesson, to compare this specimen with that of the Nuove Procuratie, at Venice, known to be by Scamozzi (Cicognara I. 62), with this from S. Giorgio Maggiore, which is probably by him also.

"Dunque nell' anno 1579 era compiuto l'interno della chiesa. Restava però a murarsi il coro, e restava anche da erigersi la facciata sul campo. Essendo poi morto il Palladio nell' anno seguente, queste opere furono compiute coll assistenza d'altro maestro . . . . Da certa carta da me veduta nell' archivio di questi spettabilissimi monaci . . . . che a me sembra di mano dello Scamozzi, si può dedurre che lo Scamozzi medesimo v'abbia posta qualche assistenza."—(Temanza, *Vite, Parte* ii. *p.* 379.)

The design of this staircase is generally attributed to Palladio, but there are some errors, instances of bad taste, &c., that incline to the belief that it is rather by some imitator of his style. The manner of ornamenting the wall by the panelling is not very elegant. The pilasters are Corinthian, *all* the mouldings are plain, and not very good. The most pleasing part of the staircase is the arrangement of the niche, &c., on the first landing, with the pedestals, &c. of the balustrade. In each side of the staircase over the balustrade is a niche and statue, as shewn in the plan. The order, mouldings, &c., are of stone—the walls whitewashed. The coving is whitewashed, and there is a fresco in the coffer in the ceiling. The steps are about 13 inches wide, the rise about $5\frac{5}{8}$ in.

WINDOW CORONET.

(Plate XXIV.)

From the University of Glasgow. Style of James I.

In the northern portions of the buildings, separating the outer and inner quadrangles, we discover apparently the tenement bequeathed in 1453 by Lord Hamilton; the other buildings, excepting those belonging to the present century, afford a good example of their particular period.

Fig. 1 is the elevation of one of the first-floor windows in the west side of the quadrangle (being the back of the main building, forming the front along High Street). These windows are six in number, and have all their crowning ornaments different, the one here shewn being the fourth, counting from the south.

Figs. 2, 3, 4, 5, and 6, are the heads to the other first floor windows, being Nos. 1, 2, 3, 5, and 6, in the range.

The dressings of these windows are not of bold projection. The width of the band in the coronet varies from, say 2 to 4 inches, with an average projection of 1½ inch. The margins are generally square, and slightly raised, but where they are small, they rather assume the form of a flush-bead. The scroll ends have generally a greater projection, have wide square margins, and are deeply cut, so as to relieve boldly.

Fig. 7 is a view of a dormer in the south end. Of the peculiar form of crowning here exhibited this is a solitary example, excepting some dilapidated remains in the west face of the clock-tower on the east side of the same quadrangle.

Fig. 8 is a perspective view of one of the dormer windows in the west quadrangle. All these dormers have span roofs; they all have, also, ornamental gables like that shewn, with one exception in the west side, the carved work of which is somewhat modified in the centre to admit the city arms, and some state insignia of the University; and another, Fig. 7.

Fig. 9 is a doorway to an octagonal staircase, in the north-west corner of the west quadrangle.

It should be added, that the lithographs are printed upon a hard paper, to allow of colour being added at pleasure; and it may be suggested, that warm tints should be avoided, where chalk lithography has been employed.

John W. Papworth.

It is requested that further information or suggestions should be forwarded as speedily as possible to the Honorary Secretary, who will deliver them to those gentlemen to whom they will be of assistance in completing the several articles on these subjects.

May 11th, 1849.

ARCHITECTURAL PUBLICATION SOCIETY.

DESCRIPTIVE NOTES TO THE ILLUSTRATIONS

CONTAINED IN THE FIRST TWO PARTS OF THE VOLUME FOR THE YEAR 1849-1850.

ARCADE.

(Plate XL.)

The church of the Madonna della Guardia is situate about three miles distant from the city of Bologna, and stands on a hill in a commanding situation, in this respect much resembling the position of the Superga, near Turin.

The present church is built on the site of one or more ancient churches, and is principally famous as containing a painting on stone, said to be endowed with miraculous powers, and purporting to be a portrait of the Virgin Mary, traditionally painted by the Evangelist Saint Luke, and brought by a hermit from Constantinople: or, as one of the guide-books has it, by a certain "Lucca Pittore, che per la sua bontà era detto il santo, quale fiori circa il secolo xv; hence the church is sometimes named La Madonna di S. Luca." The church and its relic have long enjoyed great celebrity, and so numerous were the devotees who attended to visit this sanctuary, that a covered gallery has been constructed, leading from one of the city gates, called La Porta di Saragozza, to the church itself. This extraordinary example of public spirit and devotion was projected by the Canonico Zeneroli of Pieve di Cento, who presented his memorial on the subject to the senate in 1672. The first stone of the arcade was laid 28th June, 1674, in the pier between the arches numbered 130 and 131; and the work was carried on by voluntary contributions of the inhabitants, of the corporation, and religious communities, and of profits of theatrical performances; it was completed in 1716.

The portico is twelve feet broad and fifteen feet high, enriched with fresco paintings and numerous inscriptions; it consists of two portions, the Portico di Pianera, and the Portico della Salità; it is not of one unbroken straight line, but follows the irregularities of the country over which it passes, and for which purpose, besides inclined planes, there are in its extent 514 steps; the difficulties of the ascent were skilfully overcome by the architects, Gio. Ant. Conti; Torri; Albertoni; and Laghi. The Porta di Saragozza is the magnificent arch designed by Monti in 1675, as the propylæum or entrance to the Portico di Pianera, and in 1676 the whole of the 306 arches "of the plain" were finished at a cost of 90,900 scudi (say 22,725*l.*).

Here the Portico della Salità begins; it is connected with the other by the grand arch called, from the neighbouring torrent, Arco di Meloncello, built at the cost of the Monti family, by Carlo Francesco Dotto, from the designs of Bibiena.

From 1676 to 1730 the 329 arches of the ascent were finished, with the fifteen chapels of the Rosary, at an expense of 170,300 scudi (say 42,575*l.*); and in 1739 the whole portico was completed, including, from the Porta di Saragozza to the church, 635 arches, covering a line little short of three miles in length.

The three illustrations show the entrance next to the city; part of the range of arches, taken at about one-third of its extent from the town; and the pavilion or loggia at which the gallery terminates, forming one of the wings of the church.

The present church, begun in 1723, was consecrated in 1765.

CATACOMB.

(Plates XXVIII. and XXIX.)

In the descriptions given of the ancient monuments still existing in the city of Alexandria, or in its environs, almost all travellers have mentioned the catacombs and baths; and among these last, especially those which they have denominated the baths of Cleopatra: but, with one exception only, none have spoken with exactitude, or of the details, of a subterranean monument, which is attributed to the Greek monarchs of Egypt.

Following a line, drawn in a south-westerly direction, from Diocletian's, or (as it is called) Pompey's pillar, at Alexandria, to the sea-shore, the traveller comes to some excavated catacombs; and farther south, in the rock of the same formation, facing the sea, he finds numerous excavations, in the sides of which recesses are cut. These were formerly quarries and afterwards formed the Necropolis or burial-place of ancient Alexandria.

The most spacious of these, which like the others communicates with the sea by a narrow passage, is situated about three thousand eight hundred and thirty yards south-west of the column, where, among the indentations of the sea-shore, a tongue of land forms two little inlets, on one of which is situated the baths of Cleopatra, which appear to have been the entrance to other quarried chambers; and it may be assumed that the point of land served as a terrace to the entrance of the monument now under consideration. At present, however, following the description by P. Martin (*Description de l'Egypte, Antiquités; Texte*, vol. x, p. 519), the traveller walks along the base of the rock, which rises rather abruptly from the shore, and, in the middle of the slope, insinuates himself into a hole, which is now the only means of penetrating to the interior; and through which with some difficulty he descends at the point marked *c*, by a passage about thirty-three feet long, into one of the chambers of a different monument to that which he seeks. This room is sufficiently shown by the plan and section, to be the vestibule to two small chambers, *h*, *h*, which have groined ceilings, covered with a crystalline coating, on which may be noticed red lines, drawn from the springing to the point of intersection of the groins, which serve as the centre of a disk. The vestibule is doubtlessly in duplicate; but what may exist, is inaccessible, from the sand and earth which have fallen in.

From this catacomb the traveller passes into that of which he is in quest, by an opening forced at *d* from one monument to the other.

The first apartment, into which entrance is thus obtained, is more than half filled with earth, that has fallen through an aperture built of dry stones in the ceiling, at the north-west corner, and through two others in the passage, at the places occupied by the letter *c*, and the dimension, 20 feet. This last is square; and its position, symmetric with the passages, renders it probable that all these openings were originally formed to admit light and air.

Passing southward through this passage, the antechamber

next entered is in plan as long as the diagonal of the square of its breadth. Three sides are decorated with ornamental doorways; the fourth has the wall perfectly plain: the ceiling is a segment of a circle, on which still remain the red lines, indicative of an intention to ornament it.

It is necessary here to observe, that there are material differences between the section on the line C, D, as here given, and that in fig. 4, of pl. 42, vol. v, in the *Description de l'Egypte*; differences which would render it difficult to suppose them meant for the same view; but the text and illustration absolutely describe the pediment as surmounted by a crescent, omit the disk in the tympanum, the pilasters to the side doorways, shorten the entablature over them to the width of the opening, and confuse extremely the interior portions of the centre.

Entering by this door, admittance is obtained to an elegant rotunda, which seems to be the end and object of the monument.

The French savans, having dug at the foot of one of the pilasters in this room, found brackish water, and presumed that it might be rain water, impregnated during infiltration, but decided otherwise, on finding the same water in the rooms surrounding the rotunda; and having taken levels between this point and the sea, they saw that there was only the difference (3 inches) usually caused in a syphon by filtration: this clearly showed that the floor could not be lower than the base of the plinth of the pilasters; in the process of levelling, it was found that the thickness of the rock over the cupola was 16 feet $8\frac{1}{2}$ inches.

This rotunda serves as a hall for three chambers, each again containing three recesses or tombs, in place similar to those marked *h*, *h*, in the monument first entered. And nothing, exclaims MARTIN, "is more astonishing and striking than the effect of this subterranean rotunda, illuminated by many flambeaux; their light, reflected by the crystallized coat with which it is covered, presenting many pleasing effects. The spectator admires this hall the more, as he sees it as well as the surrounding tombs or niches of the full height, it not being at all invaded by the earth like the other chambers, which are so filled as to render it impossible to investigate and judge them fairly."

Returning through the doorway *g*, on either hand similar doors conduct to nearly similarly planned passages and rooms; passing into that opposite to the one already explored, the spectator reaches a chamber with an aperture in the ceiling. This room was surrounded, at mid-height, by a brick vault, of which only the springing is seen, and which seems to have been constructed to carry a gallery in the drum. Beneath this vault is worked a hole, 2 feet 2 inches square; through which, lying flat, the spectator crawls into a passage, now stopped by earth at *f*.

Retracing his steps, the traveller will find another doorway, 14 feet 5 inches wide, specially mentioned as an arched opening, opposite to that marked *g*, and this, equally with the passages out of the corridors on each side, leads him into a magnificent hall, 53 feet 10 inches square, whose horizontal ceiling is carried by twelve great pillars. The French did not get to the centre of this hall; but, judging from the earth, which slopes down from the top of the capitals in the hall, they assumed that it had a large aperture in the middle. The "order" of the pilasters is that of the smallest pilasters in the rooms hitherto observed.

The savans observed in this hall, that the diagonals of its square were, like those of the great pyramids, exactly parallel to the true cardinal points of the heavens.

The decoration of the hall preserves the same character of grandeur and simplicity, which has been already mentioned; the two sides, parallel to the axis of the building, are alike (or were so intended to be, for it must be clearly seen that this work was never completely finished; the red lines, found here abundantly, attest that it had never received the finishing touches), and each of those parallel faces is ornamented with three doorways, the centre one 11 feet 2 inches wide, and the side portals, marked *t t*, 7 feet 11 inches, these last have their pediments drawn only, not worked. The two sides perpendicular to the axis are not so ornamented. In that yet unvisited, a doorway, 11 feet 2 inches wide, leads to another corridor, now blocked up by earth.

The arrangement of the plan of the catacombs, entered from the doors in either of the faces above called parallel, is absolutely similar, consisting of two chambers, entered from the side portals, and a larger room, 30 feet 10 inches by 19 feet 4 inches, with a recess at its end, approached by the central aperture. The plan will show how three rows of six divisions each were ranged in shelves, on each side, to receive embalmed corpses; each cavity is 6 feet 7 inches long by 2 feet wide, by 2 feet 11 inches high. These have been destroyed, and only the traces remain on the walls and ceiling. The recess is entered by a door 7 feet $10\frac{3}{4}$ inches wide, decorated with pilasters, carrying a small pediment; and the recess, or room itself, has a segmental roof. The only difference between the two sides seems be, that there exists, as marked, a conduit, through which a man may pass with difficulty, and along which the French proceeded for some time, until they met salt water, when they stopped, although the passage was open further. They fortunately found in the western burial hall a hole, $9\frac{1}{4}$ inches in diameter, broken through the wall at *e e*, so as to allow them to pass into a chamber, 35 feet 9 inches square without ornament or decoration, with an aperture in the middle, the ceiling being flat: on one side is a door, evidently leading into the general entrance to the building, now choked up.

Upon another side, however, a passage, 6 feet 10 inches by 15 feet 7 inches, leads into a peristyle supported by pillars, four of which and a door are so arranged as to make the restoration of the plan a matter of no difficulty, its axis passing through the centre of the doorway; all the rest is overwhelmed by the earth and concealed from sight; perhaps steps, cut in the rock, formed an approach from above.

In the "*Description, etc.*", *Antiq.* vol. V, Pl. 42, a map shows that the text is right in refusing to consider the baths of Cleopatra as a part of this monument, and it concludes with an appropriation of the parts of the structure, not sufficiently happy in its conjectures to be further noticed here.

In considering the entire plan, MARTIN was led to suppose, that the principal entrance was certainly that last mentioned door near the sea shore; and he would supply, not only the remainder of the plan of the vestibule, of its passage, and hall, but also would propose, on the strength of some shafts visible above-ground, to continue the chambers, which, in the early part of this notice, are termed the first monument, and supplying a similar suite on the southern side of the axis of our subject, would allow them to communicate by a grand corridor, which, running at the back of the rotunda, would unite these two wings, and form the whole into a grand and majestic design: this has been thought worthy of notice as a suggestion for a study of plan; the only objection indeed to be offered to this design, is the total absence of evidence for the original connection of the two monuments.

Such are the details of this fine subterranean work, whose formation must excite astonishment, when it is remembered that so many chambers, as well as others of which there are only indications, are all chiselled in the living rock: Mr. SCOLES's memorandum says in a compact sandstone, MARTIN calls it a calcareous formation.

[A memorandum on the original drawings, from which these engravings were made, dated 11th Nov., 1823, states that the chamber *d* was nearly filled with earth; the level of the ground had risen almost to the lower antæ capitals, so that it was necessary to rely on conjecture for the lower portion represented in fig. 2. The walls are so roughly worked, as to render it possible that they were never finished.

Fig. 3. The mouldings of the room, through which the section line C D is drawn, are very imperfect and difficult to delineate. Red lines are visible in many parts of the mouldings, as if the design were drawn out on the wall in the first instance; and that this is extremely probable, will be manifest to all those, who

know the process of sculpture prevalent in that region, and illustrated by WILKINSON (*Manners and Customs of the Ancient Egyptians*, III, 313. First Series).

In WALPOLE'S *Memoirs* (4to. Lond. 1817, p. 369) is a description of this work by Mr. Davison, who was consul in Egypt: he observes that the sepulchral chambers at Milo are very similar to these in style; and they are, of course, undoubtedly Greek works.]

In the plan (fig. 1, Pl. XXVIII) will be remarked the result of the strong feeling for uniformity, which the Greek artists preserved, and which is here shown under circumstances that would render it almost impossible for the visitor to be aware of its existence.

The variation between the cornices M and N is noticeable, as also that between those marked M and R; a consideration of the reason for this difference will amply repay the student, who will also find in the profiles S and T evidence of the mode of work adopted by the artificer.

Figs. 2, 11, and 13, are all especially remarkable for the presence of the segmental lines, which admirably suit the genius of the style, and give an extremely valuable impetus to the fancy of the amateur of Greek art; however late may be the date of these works, on which no opinion is here offered, the fact is of itself convincing.

Was this, urges MARTIN, the tomb of the Ptolemies, which the Alexandrians were so eager to show to Augustus after he had visited the monument of Alexander (SUETONIUS *in Aug.* 18), or that famous work in which Cleopatra was taken prisoner by Proculeius? Until antiquaries can fix the position of these buildings, which were probably in one group, this monument may claim fairly to be the representative of our ideas as to the sepulture of the Greek monarchs of Egypt: for few small works of pure architecture combine, with dignity, so much that is captivating to the eye, as is represented in these two plates.

CEILING (MOSAIC).

(PLATES XLI. and XLII.)

The magnificent sacristy of the church of S. Luke at Venice, is, although not rectangular, a noble apartment, and has been considered as often serving for a chapter-house to the canons of the basilica; it is indeed very rich, from the precious mosaics executed between the years 1517 and 1530, and restored by order of the senate in 1727.

The vault was the work of Marco Luciano Rizzo, who was assisted by the priest Alberto Zio, and also by Pietro Alberti and the celebrated Francesco Zuccato (ZANETTI, *Della pittura Veneziana*. 4to. Ven. 1771, p. 567, and MOSCHINI, *Guida di Venezia*. 12mo. Ven. 1815, vol. i, p. 302).

The work is as beautiful in execution as in the invention and grace of the decorations and in the treatment of the figures, which by some are thought of the school of Titian, and even by that master himself: the SS. Giorgio and Teodoro, in the ceiling, are by his friend Zuccato after Tintoretto.

In many places the artists have left names and dates; and everywhere there is something deserving of praise and a separate illustration. CICOGNARA (*Le fabbriche, etc. di Venezia*, fol. Ven. 1838, vol. i, p. 17) particularizes some of the principal works; among them he mentions the two representations of S. Girolamo, done in competition with Zuccato and Bartolomeo Bozzo by Domenico and Giannantonio Bianchini; the fourteen figures of the Apostles and SS. Marco and Paolo, which ornament the chief part of the lunettes; and, finally, the corresponding figures of the Prophets on the vault, which surround the cross placed between the four Evangelists.

The room is nearly 66 feet long, by 26 feet 3 inches at the smaller end, and 30 feet at the larger extremity.

Plate XLII shows a portion of the design, represented at the top of the former plate, on the left hand of the spectator.

The custode assured Mr. Lewis, that it was not recollected that any other artist had made a study of this superb work: inasmuch as the time requisite to habituate the eye to the gloom of the apartment is rarely given, visitors pass without notice one of the rooms and its contents, most worthy of their attention, even in the splendid basilica of S. Mark.

CHAPEL.

(PLATES XXX. and XLIII.)

The architecture of this chapel (the sixth), in the church of S. Domenico, at Bologna, is proved, by the archives of the convent, to be the design of Francesco Terribilia, the architect of the Scuole Pie, at Bologna, a building which has often been erroneously attributed to Palladio, so great is its merit. In the chapel now illustrated, Plate XXX, a fresco on the roof by Guido represents the glory of Paradise, with the Saviour and Virgin receiving the soul of S. Domenico, amidst the music of the seraphim. Of this BELL says:—"In the highest circle of the dome, a soft radiance emanating from the Holy Spirit illuminates the picture, touching with partial lights the heads of the Saviour, of the Virgin, and of the saint, who are placed at equal distances; while a choir of angels, exquisitely designed and finely coloured, fills the whole space below."

The subjects in the lunettes, and the figures representing the virtues of the saint, are by Mastellata, as also two of the great historical pictures: the other pair are the masterpieces of Lionello Spada and Tiarini; the last-named work was especially admired by Ludovico Caracci.

At the end of the chapel stands the tomb of S. Domenico, commenced in 1225 by Nicolo da Pisa, completed three centuries later by Alfonso Lombardo, and exhibiting a specimen of the early genius of Michel Angelo Buonarotti. This work forms, it is said, an epoch in the history of art, which ought to be closely studied by every person desirous of tracing the progress of sculpture since the thirteenth century.

The illustration is a beautiful example of well-applied colouring in the internal decoration of sacred edifices, as well as of an effect seldom obtained in modern structures of this class.

Sta. Trinita de' Pellegrini at Rome, Plate XLIII, was built by the architect Paolo Maggi, in 1614. The picture over the high altar is the Trinity by Guido Reni. The effect of the columnar arrangement to the piers of the dome would be very fine, but it is spoilt by the manner in which the columns, etc., are painted. The roof is in imitation of veined marble, and six of the columns are finished in the same way; while the two nearest the altar are painted like sienna, which quite detaches them from the general composition. In this, as in the preceding case, the drawing supersedes the necessity of verbal description.

CHIMNEY.

(PLATE XLIV.)

Figs. 5 and 8 are from the Palazzo Madama, at Rome, built in 1642 by the famous Catherine de' Medici, from the design of Paolo Marucelli.

Fig. 13, containing five, and Fig. 12 having thirty-five, flues are from the side of one of the towers of the principal front of the château de Chambord. The roof is the glory of Chambord. The whole top of the building is one grand terrace, paved like a marble court. Immense pointed roofs, more than fifty feet high, rise above the towers like ornamented pyramids, studded with magnificent dormers and gables, intermingled with elegant chimney shafts and towers, decorated with niches, and flanked with columns in most beautiful proportions. Primaticcio has been mentioned as the architect, but this point still remains undecided. The château is said to have been commenced in the reign of Francis I, after his return from Spain, about the year 1526.

Fig. 14 is noticeable as conveying the stamp of style; and all the larger examples in this plate should lead to a consideration of the success which attends a continuation of the features of a façade into these too often neglected portions of a building.

Fig. 19 is from the Château de Blois, and from that part of the edifice erected by the architect Mansard by direction of Gaston d'Orleans in the reign of Louis XIII. It is between 20 and 25 feet in height.

CORBEL.

(Plate XXXI.)

There exists a remarkable similarity between the examples given in this plate, especially between figs. 2 and 3, in the arrangement of the lintels.

In the instance represented in fig. 3, stone corbels project about four feet; the whole of the upper lintels are in one piece, dropping into the corbel as shown by the joints, and the lower part abuts against the great corbel: the triangular pieces appearing like smaller brackets, are features repeated in fig. 2. Behind them is an arch of brickwork plastered on the soffit; the remainder being of a very hard coarse volcanic sandstone.

The beautiful effect of the soffit of fig. 1 may be remarked.

FAÇADE.

(Plates XXXII and XLVI.)

The adaptation of ornament to construction and the very beautiful cornice exhibited in the illustration from Rouen, Plate XXXII, render this example a very desirable contribution.

The house at Nuremberg built in 1605 now belongs to the Fuch's family. The name of the architect seems to be unknown. The adjoining (modern Gothic) house was the one inhabited by Gustavus Adolphus. It was, in 1828, restored to its present state by Heideloff.

At Montepulciano, the church of the Madonna di S. Biagio, built from the designs of San Gallo, is one of his most approved works; several private palaces in this locality are by the same master; the critic, judging the drawing Fig. 1, Pl. XLV, will not be disinclined to attribute this rectory-house to the hand of the above-named artist.

The Corpo di Guardia at Padua (Fig. 2) is a most elegant work of the period of the revival in Italy. Unfortunately it has not been possible to ascertain the name of the artist who was engaged upon so successful a design.

The illustration from Ypres, Plate XLVI, is a rich and good example of the form of street houses in Belgium and French Flanders during the sixteenth and seventeenth centuries. The whole of the upper part, including the decorations, is in brickwork, the basement portion only being in stone.

FURNITURE.

(Plate XXXIV.)

The marble table is a genuine relic of the taste prevalent under the Norman rule in Italy.

The back of each of the illustrated desks forms a seat, and they are ranged in two rows of parallel files, end facing end, one down each side of the Laurentian library at Florence; the volumes, until wanted for study, are chained to their places. The panel of the pilaster, at the end of each desk, contains the title of the several manuscripts, the works being classed upon and in their desks, which thus form a basis for the catalogue.

The desks, or "banchi", literally seats, were made under the superintendence of Michel Angelo Buonarotti, and are considered by Rossi (*La Libreria Mediceo-Laurenziana*, fol., Florence, 1739, p. 24), not only consummately designed, but also perfectly carried out, both in the joiner's work (*nel lavoro quadro*, a rare merit) and in the carving. In his Plate XV, he has given one of them; with four examples, to a larger scale, of the ornamental work, which occupies the rectangular and triangular compartments, and he says, that "they are worked with such a mastery, to say the truth, executed with such subtlety and delicacy, and with such liveliness, that little more could really be obtained in wax or in bronze."

The artificers, who had a hand in this work, were Batista del Cinqui and Ciapino, both of them very clever men and most dextrous workers, as is attested by Vasari (*Vita di Ciapino*), who, to the perpetual glory of their name, emphatically calls them *buoni maestri*.

"And indeed, continues Rossi, whoever tolerably skilful will set himself to examine these carvings, not cursorily but well and minutely, will not fail to be highly surprised," seeing wood treated by the tool with such freedom and carefulness combined, and with such inexplicable dexterity, that Rossi himself, wishing to display their refinement and grace, found it impossible to impart to his engraving the touch, with which the master-chisel had stamped its labours. Still, to render his book less imperfect, he could not refrain from ornamenting his essay with such noble and admirable intaglios, setting aside the others, which not only differ from these, but from each other; all of them being most exquisite, and worthy to be placed in that theatre of so many other precious labours, each of which rivals the other in beauty, and leaves the spectator doubtful to which he should give the supremacy.

Of the two bronze candelabra from Messina, nothing need be said; they recommend themselves to every eye; but it is well to compare them and that from Venice, as specimens of the adaptation of a design to the material, with that by A. Orgagna from Florence; this is as appropriate for marble, in which it is worked, as the others are for metal.

LOGGIA.

(Plate XXXIII.)

The magnificent palace of the governor, or the Palazzo Apostolico, at Loreto, of which further mention will be made (Pl. XLIX, "Piazza"), an edifice worthy of any capital, was begun in 1510, by Julius II, from the designs of Bramante.

It forms two wings, composing the half of a parallelogram, and is constructed with two grand ranges of loggie, the lower of the Doric and the upper of the Ionic order, with thirteen semicircular arches on the ground floor of the long side, not including the campanile, seven of the same description forming the shorter side.

The former of these loggie affords access to the apartments occupied by the canons of the church; the upper range is inhabited by the bishop and governor, and contains the noble room called the "Apartment of the Princes", now used as a picture gallery.

The external view of this building is given in Plate XLIX, and it only remains to observe, that the distant background of the present illustration exhibits the centre of the shorter side of the quadrangle, facing the Chiesa della Santa Casa.

METAL WORK.

(Plate XLVII.)

The three upper knockers are from Nismes, and the two lower from Berne. That numbered Fig. 4, is from the cathedral at Berne, and placed ou the outside of the door on the top of the tower roof.

PEDESTAL.

(Plate XLVIII.)

Fig. 1 is an illustration, unhappily too rare, of the sumptuous methods which this style affords to the architect who is desirous of overcoming the difficulties of a ramp in stone or marble.

Fig. 2 is an example, ornamented by a Mazzoccho or emblematical lion of Florence, from the Palazzo del Podestà now the Palazzo del Bargello or chief of the police, used as a prison in that city. Having been erected by Jacopo di Lapo, its date and style are easily determined.

Fig. 3 is from the gardens of the Borghese Palace, and forms a pleasing termination to the protection of a terrace walk.

PIAZZA.

(Plate XLIX.)

The Piazza della Madonna at Loreto represented in a view, engraved from a very careful drawing by Mr. John Davies, is occupied on one side by the monastery of Jesuits, at one end by the church called Chiesa della Sta. Casa, and on the other side and end, by the noble palace of the governor, shown in Plate XXXIII, "Loggia".

On the platform ascended by nine steps, in front of the church, is a fine bronze statue of Pope Sixtus V, representing him seated on an octagonal pedestal, giving his benediction: it was the work of Calcagno di Recanati, pupil of Girolamo Lombardo di Siena and executed in 1589.

The great ornaments of the exterior of the Chiesa della Sta. Casa, are the superb bronze doors, hardly inferior to those of the Duomo at Pisa: the central one was cast by the four sons of Girolamo Lombardo in the sixteenth century, and is divided into compartments, containing bassi-rilievi, illustrating the history of the Old Testament, from the Creation to the flight of Cain, with symbolical representations of the progress and triumphs of the church. The left door was cast by Tiburzio Verzelli of Camerino a pupil of the elder Lombardo; it represents, amidst rich arabesques and figures of prophets and sybils, various events in the Old and New Testament histories, so arranged as to make each symbol of the old law a figure in the new one. The right door is the work of Calcagno, assisted by Jacometti and Sebastiani also natives of Recanati; it represents in the same manner as the preceding one different portions of both Scriptures. These fine works were finished under Paul V.

On the grand door is a full length bronze group of the Virgin and Child by Girolamo Lombardo.

The campanile, of great height, exhibiting a combination of the four orders, was designed by Vanvitelli and finished in the pontificate of Benedict XIV; it is surmounted by a remarkable bulbous pyramid, and contains a bell, said to weigh 22,000 lbs., cast by Bernardino di Rimini in 1516, at the expense of Pope Leo X.

The octagonal cupola of the church, begun by Giuliano da Majano, was strengthened at its base and nearly restored by Antonio San Gallo: whose skill and judgment in the execution of this difficult task have received the praises of Vasari.

The bronze fountain, ornamented with armorial bearings, eagles, dragons, and tritons, is the work of the pupils of Calcagno. (*Hand-book for Central Italy*, pp. 121-125.)

PULPIT.

(Plate L.)

Fig. 1 is remarkable on account of its well-ascertained date; it being from the uppermost church of the Sacro Convento at Assisi, over the remains of S. Francis; commenced by Jacopo di Lapo the German in 1228, it was completed within two years, and is a building which has a peculiar value in the history of architecture, as being one of the examples in which the introduction of Gothic art into Italy is established beyond the possibility of doubt. Blue and red colours have been applied to the field of the ornaments.

Fig. 2 is from the Sacro Speco, the famous monastery built over the cavern near Subiaco, which S. Benedict converted into his hermitage. It is in the upper church, a building dating from 1066, and thus gives a specimen of the style prevalent before the time of Jacopo.

Fig. 3 is a work by Antonio Gagini, who died 17th Nov. 1571. It is of white marble, and the extremely careful finish bestowed upon so many ornaments and figures gives a peculiar magnificence to this very noble design. The pulpit has no sounding board, in which it resembles nearly all others in Italy and Sicily; an awning suspended during the sermon, over the preacher and his auditory, supplies the place of that accessory, so generally disgraceful in the churches of France, and too often ill-managed in those of Great Britain.

SCREEN WALL.

(Plate XXXV.)

In the gardens of the Villa Doria-Pamfili at Rome, attributed to the middle of the seventeenth century, the grand esplanade is crossed at one of its ends by a terrace, comprising four of the walls shown in the upper specimen of this plate: they serve to retain the earth of a bank used for grottos, caverns, etc.

The centre of the terrace formed by two gently rising staircases is semicircular, facing and of the same width with the esplanade, and decorated with grottos, statues, bas-reliefs, and hydraulic tricks; the superincumbent earth is held back on each side of the hemicycle by two of these walls, with a grotto between them; that of the Tritons may be seen in Plate XVII of Percier and Fontaine (*Choix des plus Célèbres Maisons de Plaisance*, fol. Paris, 1810); and it is not uninstructive to observe the different opinions with which the French and English architects have regarded this example.

Each wall is about 65 feet long; the dimensions in height, are 3 feet 7 inches to top of basement, 2 feet 8 inches to top of pedestal, and 2 feet 2 inches for each vase; in length, 7 feet 10 inches from centre to centre of pedestals, each die of which is square.

The screen-wall of the garden of the Palazzo Doria is represented in the next view, taken from the street. It is the work of Valvasori, and, from the olden French character of the architecture, and the use of the escallop shells and fleur-de-lys, fully carries out the general style of the building to which it is attached; the reversed balusters are noticeable.

STAIRCASE.

(Plates XXXVI., XXXVII., XXXVIII. and LI.)

Fig. 2, Pl. XXXVI, is from an edifice at Angers, originally built by the intendant of the province as his residence, and now used as the museum. The staircase is situated in the angle of a partially-cloistered court; its plan is octagonal in the lower story, carried into a square at the second floor by means of a long straight corbel, commencing in a point at bottom and covered with small knots of foliage: in many respects it has points of similarity with that in Fig. 1, from Genoa, and the differences are worthy of especial consideration.

The staircase from the Palazzo Lancellotti at Velletri (Pl. XXXVII), is considered as one of *the* staircases of Italy: every traveller is charmed with it, yet this cannot arise from anything

but the elegance of the design, for no adventitious ornament is bestowed upon it. The view from the corridor, containing the ruins of Cora and the adjacent country, is also one of the favourite studies of the artist.

The illustration, Pl. XXXVIII, is from the Palazzo Ercolani at Bologna, which was restored, at the close of the last century, from the designs of Venturoli. This example is worthy of particular study, the gallery round the actual staircase being one of the means of effect most rarely placed at the disposal of the architect.

Fig. 2, Plate LI, is an illustration of an unobtrusive feature in the older portion of the noble Palace of the Braschi family at Rome, being a back, or private staircase of inconsiderable dimensions; but it demonstrates admirably, that genius may as readily betray itself in small works as in large. Here is a lobby with a few steps down to the cellars, and another small flight 7 feet 2 inches up to the principal floor level. A vulgar hand would have either made of this the commonest possible object wholly undeserving of notice, or it would, in order to have attracted attention, have overlaid it with a quantity of plaster frippery, under the false and fatal impression that beauty necessarily lies in ornaments. But here the artist had given us perfectly plain walls, such as befit a subordinate passage way, with no ornament except a few coffers in the ceiling, which help to give value to the surrounding plainness. A simple and graceful statue, meets and occupies the eyes at first entering the lobby, and is well calculated to give the impression of a pleasing welcome. This statue, 5 feet 9 inches in height, is placed on a pedestal, 1 foot 8½ inches wide, and 5 feet high. The stairs on each side are 7 feet wide; the landing in front of them, 15 feet 8½ inches wide; and the steps nearest the spectator, 5 feet narrower. The risers are 6½, and the treads 14 inches.

The specimen from Venice is far larger than that last named, and of greater pretension; it is highly picturesque and even scenic, without any extravagant exercise of the means and appliances of architecture. There is much dignity in the composition, and much variety of light and shade; while the agreeable play of curved lines shows the skill and thought of the designer. In this case, as in the former, the whole effect is produced without the aid of any positive colour; the general hue of stone prevailing throughout, with but few slight varieties of shade.

The flight of steps occupies 33 feet in length, without the bottom landing, and is 9 feet wide. Three steps at the further extremity, on the left hand of the spectator, lead to the commencement of the return flight going upwards.

TOMB.

(Plate XXXIX.)

The first illustration is that of Georgius Costa, a Portuguese, patriarch of Lisbon in 1476, and made cardinal-bishop of Albano by Pope Innocent VIII. In 1480 he was sent as legate to Venice, and died 19th September 1508, being then more than one hundred and one years old. The date of his tomb, in the church of Sta. Maria del Popolo, at Rome is fixed by his having prepared it for himself, as witness the upper inscription:—

GEORGIUS EPISCOPUS ALBANEN: CARDINALIS
ULYXPONEN: DUM SE MORTALEM ANIMO
VOLUIT VIVENS SIBI POSUIT.

It is to be regretted that these beautiful works are not oftener found in the sketch books of students.

The second example is taken from a careful representation, made by Mr. Sydney Smirke in 1825, of a sepulchral monument, of the date 1359, preserved in one of the chapels of the Campo Santo, at Pisa, to M. Ligo F. Ammanati, professor in the university.

As a work of art, this piece of sculpture has considerable merit; there is some elegance in its form and great delicacy in the details; the date inscribed upon a fillet of the pedestal gives it additional interest in the eyes of an antiquary.

This monument is a curious illustration of the remark frequently made by those who have become acquainted with the Italian architecture of the middle ages, that the artists of Italy adopted, less readily than those of other countries, the style everywhere prevailing in Europe during a portion of that period.

The intimate mixture in this example of the Classic and the Pointed style is obvious; the pinnacles, the crockets, the cusps of the arch, have all a general resemblance to similar works of the same period in England; but the form of the arch, the trusses, and many of the enrichments, bear the strongest marks of their classic origin. This incongruity of style characterizes almost all the attempts of the Italians at designing *alla maniera tedesca*, and has greatly detracted from the elegance of many, both of their architectural and sculptural works, in which the beautiful execution of the details leaves no doubt of the power and taste of the artist.

Signor Asinio mentioned to Mr. Smirke, that the figure was the well-known work of Giovanni Pisano.

The lithographs are printed upon hard paper, to allow of colour being used at pleasure; and it is suggested, that warm tints should be avoided where chalk lithography has been employed.

John W. Papworth.

It is requested that any further information or suggestions may be forwarded to the Honorary Secretary, who will deliver them to the gentlemen who purpose undertaking the several articles on these subjects.

April 30th, 1850.

ARCHITECTURAL PUBLICATION SOCIETY.

DESCRIPTIVE NOTES TO THE ILLUSTRATIONS

CONTAINED IN THE FIRST PART OF THE VOLUME FOR THE YEAR 1850-51.

It should be premised that these Illustrations are expected to form the graphic portions of those articles, which will have the same name or title, and that thus a step is made towards the commencement of a Cyclopædia, without waiting for the natural course of the text, to which they relate. Under whatever circumstances these plates may come into the hands of the Architect or Amateur, whether with text or without any more than mere description of locality, position, date, and size, they will certainly be of great value; not so much that nearly the whole of the specimens presented have not before been published, as that they are ranged in a series, and are carefully selected for their intrinsic merit.

The little, that is needed to be said of each example, will find its natural arrangement, by the name or title of the Subject, under which all the Plates are here grouped together.

ARCH.

(Plate LII.)

The very suggestive example from the Palazzo del Tè at Mantua will be better appreciated upon reference to the notes upon the grotto belonging to the same edifice (see Loggia below), which will give some idea of the magnificence to be obtained by the mode of decoration which has been adopted: attention must be called to the soffit for the cantilevers, which is square with the vault, and not, as most would have made it, on a plane parallel with the floor.

A very clear and skilful mode of obviating a difficulty is shown in the instance of the doorway from the Palazzo Farnese, which, occurring at the angle of a cortile, was restricted as to its inner aperture by the necessity of introducing the pillars, and, on the outside, had to be kept in uniformity with other portions of the façade.

The entrance tô the staircase in that palace, from the quadrangle, illustrated on the same plate, is another specimen of how the obstacles presented to a practised architect may be removed in a manner scarcely sensible to the eye even of a professional man: the ramp is very ingeniously contrived and compensated, and the whole is grand and impressive. The opening is twelve feet wide in the clear, and sixteen feet nine inches high to the springing, with a semicircular arch. The piers are four feet four inches wide, and three feet deep.

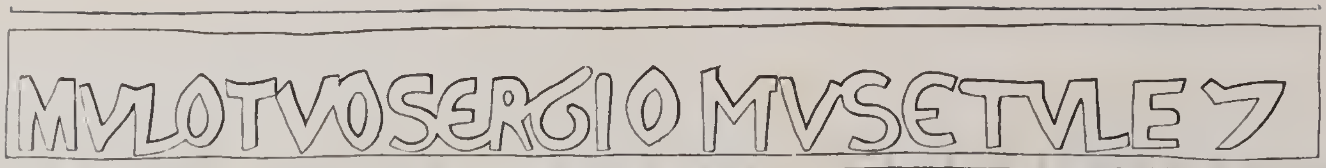
CORBEL.

(Plate LIII.)

The subject of this plate has been selected for the purpose of shewing a complete specimen of this class of ornament; which, from its extremely difficult and intricate combinations, has hitherto only appeared, on a sufficiently large scale, in the finest and most expensive works upon Architecture: the subject, taken from another point of view, will be found in plate iv of Gally Knight, *The Saracenic and Norman Remains in Italy*, folio, Lond. 1838. That author derives the name of this, one of the three villas of the Moorish princes near Palermo, from Alaziz, the last word in the Arabic inscription on the walls of the open hall on the ground floor, which is in a good state of preservation, and is an exact counterpart of the luxurious retreats which are so universally seen in Mahomedan countries.

This hall, connected by a wide arch with a corridor, which stretches along the front, and formerly opened into an orange garden, has three recesses; in one, (that opposite the arch,) is a fountain, of which the waters are conducted in channels across the marble floor; and supplied, till 1526, a fishpond, 50 feet square, in which stood a pavilion, two stories in height, for the ladies of the palace and their damsels. The walls are enriched with mosaics, and portions of the plain part have been covered with very bad paintings of a later date. The floor, now much worn, has been inlaid. The hall is not the less curious from its having been worked upon by the Normans; in consequence of which, it now exhibits the blended performances of the two nations—Norman and Saracenic ornaments standing side by side. The Norman additions are small marble pillars and mosaics; the pillars, which are introduced at the angles, and at intervals along the wall, having foliaged capitals, with animals intermixed. The Norman mosaics represent huntsmen and peacocks, as at the Palazzo Reale (Palermo); but the lowest band of mosaics which goes round the hall, is a repetition of flowers; and so entirely Arabic in its character, that either it must have been a portion of the original work, or copied from Saracenic designs. The additions were made by William the first of Sicily, 1154-1169; who, by some, is represented to have entirely built la Ziza; his partiality for the Saracenic portion of his subject gives great foundation for this opinion; though Knight considers that the varieties of style, and the dissimilarity of the bulk of the building from Norman work, leave no reason to depart from the more generally received opinion.

The honeycomb ornament, which appears a mere sport of fancy to the eye, is formed upon an uniform plan, and in a very scientific manner. It consists, as is shewn by Mr. Owen Jones, of a series of parallelograms and right-angled triangles, so combined as at once to produce uniformity and variety—the first by the structure of the ornament, the other by the painting and the gilding.



DOOR.

(Plates LIV. and LV.)

A local guide book relates that these doors of the Duomo, at Ravello, were brought from Constantinople, which is not unlikely, as the fine gates at S. Germano, made a few years earlier, were undoubted importations of Byzantine art. One line of the inscription, a facsimile of the original, as to shape and size, is illustrated by the woodcut, and the following form is an endeavour to give the epigraph, as efficiently as the type obtainable would admit.

A N N O M I L L E S I M O
CENTESIMO SEPTVAGESI
MO NONO INCARNACIO IESV
XPODÑONRO MEMENTO DÑEFA
MVLOTVOSERGIO MVSETVLE7
VXORI SVE SICLIGAVDE 7 FI
LIIS SVIS MAVRO 7 IOHES 7 FI
LIA SVA ANNA 9OT ISTAPOR
TAFA CERE A CIT ADHO
NOREM DEI 7 SANCTE MA
R I E V I R G I N I S

It is curious that there are several sets of somewhat similar bronze doors in the south of Italy; Palermo, Amalfi, and Mainri having examples, though none of them are by any means so elaborate and richly adorned with figure-subjects as those at Ravello. Certain deficient panels in one of the two sets pertaining to the cathedral at Monreale, have been supplied with casts from the Ravello originals.

FACADE.

(Plates LVI, LVII, and LVIII.)

Reference may also be usefully made to plates VIII and XLIV.

Holland does not contain many architectural features of high antiquity or interest to the archæologist or architect. The specimens of domestic architecture, illustrated for instance in plate XIX, are rare, and are almost unique instances of mediæval art. They are situated on the quay at Delft, which, ere railroads were introduced, was in the high road from Rotterdam to the Hague. There is the façade of another edifice immediately attached to this building, of like character, somewhat varied in detail, and the two together form a rich and imposing elevation.

The whole is of a very florid character, and corresponds with the English style of the sixteenth century.

Yet the Flemish towns still retain many fronts of houses of two or three hundred years ago, strikingly picturesque in form and often elegant in detail. The example, in plate LVI, with its high pitched stepped gable, its Gothic headed openings, and Italian mouldings, presents a very effective composition, illustrative of the struggle between the old and the new tastes, and the style of the transition from the one to the other.

The lower part is a restoration, in lieu of a modern shop front, which sadly mars the rest of the work; but the string-course immediately over the lower windows still exists. The windows of the first floor offer the Gothic feature of the large bead moulding, with a regular base, running all round, and enclosing the large shell over a square aperture.

The little tablets on the piers, to contain a name, a motto, or a date and the ornamental irons, which tie the front into the ends of the principal timbers, all aid in the general decoration. The three upper windows, in keeping with those below, follow in gradation the pitch of the gable end; but the string-course over the first floor is fully Italian.

The brick examples from Bruges, in the second plate of these illustrations, are easily recognized as instances of the style of domestic architecture in the seventeenth century—that is, in the years 1626 and 1673—for, by a happy practice, the dates of most of the houses are marked on the front, either by the form of the iron ties shaped into numbers, as is frequently the case in old English houses, or by inscriptions in small tablets. In the earlier of those two examples, the lower range of windows has square heads and transoms: a wide blank space then occurs up to the sill of the one-pair windows, which forms a continuous string-course extending along the whole front. This blank space may possibly have been meant for an inscription, or perhaps might have received a fresco, as was the practice in many of the Italian cities. The windows of the first floor have square heads and transoms also; but the sentiment of the decoration is marked by semicircular arches, within which is the usual trefoil tracery, superseded in the two centre windows by small tablets. These central windows, divided by a buttress pier, have the outer splay carried up, so as to form a pleasing contour, including an upper opening and a higher aperture in the gable to light the roof. The gable is stepped in the manner usual at the period in Scotland, yet very rarely practised in England: one instance, at Ipswich, may be due to the intercourse of olden times.

Although the gable in the next instance is similarly worked, yet the design shows the progress made by Italian taste in the half century. The Gothic trefoil yields to sculptured subjects, and the archivolts and keystone supersede the splayed continuous reveal of the earlier style. The quoin stones also mark another departure from mediæval art. The splayed niche in the angle, to receive a statue, produces an agreeable variety in the outline. T. L. D.

The Palazzo Fibbia at Bologna belongs to the class of buildings almost peculiar to that city. The façade is composed (with the exception of the columns) entirely of brick and terracotta, the latter being used for the enriched mouldings. It is a good example of the pleasing effect resulting from the use of this material for external decoration, considerable richness being given at really small expense. The flowers and fruit in the corona of the cornice are peculiarly beautiful, and the ornaments generally are so judiciously introduced as to render the building well worthy of notice. The colonnade on the ground floor is also a feature of Bolognese architecture; the palaces, with few exceptions, are so constructed as to afford a sheltered walk from one end of the city to the other.

The Palazzo called Cornar Spinelli, but by Cicognara (*Le Fabbriche, etc., di Venezia, fol. Ven.* 1838, vol. p. i, 125,) entitled formerly of Cornari, and lately the Theatre of S. Angelo, is

praised by him for the dignity of its cornice, as well as for the effect obtained by the use of inlaid marbles in the plainer part of the walls, by the execution of the capitals, and by the festoons which enrich, not only the frieze of the great cornice, but also the basement near the water. The material is Istrian stone.

GATEWAY.

(Plate LIX.)

The example from the Palazzo Durini, at Milan, is remarkable for many features, which require little more than careful study to render them useful to the architect in the production of a striking yet modest work.

Vanvitelli, in his Porta Pia at Ancona, has succeeded in obtaining majesty; and it may be remarked, that in such works height, at least sufficient to receive a portcullis when drawn up, as in gothic construction, is absolutely essential to dignity.

This has received attention in the more picturesque example, from the dockyard at Leghorn, which forms one of the most unusual, as well as useful, lessons in practice at the present time.

LOGGIA.

(Plates LX and LXI.)

This small Loggia forms a portion of a very beautiful little building situated in the gardens of the Palazzo del Tè, at Mantua, called the Grotto, and erected under the superintendence of Giulio Romano. The decorations are mostly in arabesque, and are not excelled by the very best Pompeiian examples. The ground of the large panels is a rich cream color, and the tints for the animals, leaves, etc., are extremely delicate, the necessary richness and force being given to the whole by the deep chocolate grounds of the small centre circular panels, and marginal lines. The manner of introducing paintings on the walls and ceiling is very effective; and the small designs in raised stucco on a green ground, round the ceiling panels, forming frames to the pictures, are well arranged. A green ground for raised stucco work, seems to have been much in favor in this palace, as it is very extensively used. In the Camera dei Bassi relievi, so called from its having a double series running round the walls of the room (the coffers in the vaulted ceiling being also filled with bas reliefs), these are all on a green ground, and the effect of the white plaister is very soft and harmonious. The stucco work throughout the palace, and indeed throughout Mantua, with scarcely any exception, is white and gold, color being only used on flat surfaces in panels. Arabesque decorations by Giulio Romano and his school abound in this city; and the Ducal Palace contains many very beautiful examples well worthy of study.

These latter, too, remain in their pristine state, this portion of the palace having been closed since the sack of the city by the Germans in 1630, who removed everything that was saleable; but fortunately for art, arabesques and stucco work, however beautiful and effective in their proper places, will not bear removal. The Palazzo del Tè is altogether in better order, artists having been employed previous to the late outbreak in Italy in restoring the decorations generally.

The exterior elevation, fig. 1, of plate LXI, is useful, as showing the disregard in the mind of the designer as to carefully centering the decoration with the construction of the work.

The details are given for the purpose of showing the whole of this beautiful work, and for the correct explanation of the colored illustration, which will appear in a succeeding part. This plate has been selected from illustrations, by the kind permission of the author, Louis Gruner, Esq.

MAUSOLEUM.

(Plate LXII.)

The Toorbah, or Tomb of the Sultan Matesseb, as it is called by the Arabs, is one of the best illustrations of the fertile ingenuity of the Mahomedan artists; the junction of the dome with the square base is one of several modes which they adopted of obtaining an agreeable outline; and it will readily be allowed that many cases occur which demand similar means of obtaining the execution of a pyramidal design.

METAL WORK.

(Plate LXIII.)

It will be observed that the specimens here given, are really in their proper position, although the keyholes seem reversed. The portion from Basle is fastened by five screws with ornamented heads, which will easily be discovered forming the roses of the foliage. The grille from the church of St. Gudule at Brussels is very happy in the production of an effect which must be judged of by the small illustration of its arrangement accompanying it, showing how so small a portion will produce one entire and perfect design in metal work, as well as in stone or in tapestry; but the chief merit of these, as well as of the other subjects in this plate, consists in the careful adaptation for the design, means, and material of manufacture; with the manner in which blemishes are converted from absolute faults into beauties in each instance.

The lithographs are printed on hard paper, to allow of colour being used at pleasure; and it is suggested that warm tints should be avoided where chalk lithography has been employed.

John W. Papworth.

April 30, 1851.

ARCHITECTURAL PUBLICATION SOCIETY.

DESCRIPTIVE NOTES TO THE MISCELLANEOUS ILLUSTRATIONS
CONTAINED IN THE THREE PARTS OF THE VOLUME FOR THE YEAR 1851-52.

Upon the commencement of the Dictionary, the Committee has been requested to issue a title-page for the works hitherto brought out by the Society, so that those, who desire to bind their set, may be enabled to do so at once. The title-page and directions to the binder therefore accompany this part, which completes the works of the first four years, and will form a tolerably thick volume.

BALUSTRADE.
(Plate XCVI.)

If Genoa is remarkable above all other cities for its internal staircases, Naples is certainly not less so for those on the exterior of its principal buildings.

The steepness and irregularity of its streets entail the necessity of these adjuncts in many places, and the ornamentation of them has passed into a peculiarly well-developed architectural localism; so that they are frequently placed where not unavoidably requisite, but where they only indicate the wealth of the proprietor, and the skill of the architect, beauty of workmanship and richness of material being profusely lavished on them. The balusters to the church of the Spedale Generale, near the castle of S. Elmo, is of very highly coloured jaspar, but are not in their original position, having evidently been brought from some other building to decorate this, when it was restored and rebuilt by one of the Aragonese princes. The remainder of the work is of white marble, and the steps of lava.

The third illustration is from one of the side chapels of S. Francesco, and is richly inlaid with lazuli and serpentines, both on its console, rail, and parapet.

COURT. (Algiers.)
(Plate LXXXVII.)

The court (in Spanish, *patio*) of the palace of the Dey, is one of the richest and most splendid examples of architecture in Algiers. The building is situated in the centre of the town, and is now the official residence of a bishop. With regard to the illustration here given, it is only needful to observe that two arcades, one above the other, enclose a court-yard paved with marble; one staircase originally led down to the ground-floor, to the room formerly destined for the entrance saloon (it is now the private chapel), and another to the reception rooms, which are separated from the hall before-mentioned by another hall, corresponding to three columns of the gallery. On the first floor there are three long and narrow saloons, which are remarkable for their rich decoration in plaster, similar to the work in the Alhambra, but without colour, and these commence at about six feet high, the lower portion of the walls being covered with painted tiles. The ceilings are made of wood, coloured and gilt with much taste. In the centre of one side of the great saloon is a square recess, vaulted octagonally and called in Arabic *marabut*. The lower columns are spiral, but the upper ones are octagonal in their lower part, and are all of white marble. The arches upon the columns are of the horse-shoe shape, but those of the doorways are circular, and enriched with dressings of white marble, in a style scarcely that of the Arab architects. A course of painted tiles surrounds each arcade below the roof and railing, and recalls the vertical direction of the general design, by uniting with the plain band above each capital. Painted tiles are also placed upon the walls of the two galleries, in panels, but their design is not quite Arabic, and is deficient in point of taste; the colours are those usually employed in works of this kind in Spain, viz., yellow, blue, and a red, now approaching to brown, giving a little warmth to this piece of architecture, which externally is simply white. The railings between the columns are of wood, and in a style rarely observable in similar portions of a design.

COURT. (Barcelona.)
(Plate LXXXVIII.)

The court of the House of the Provincial Assembly at Barcelona is the finest monument of mediæval times in that city, excepting the cathedral. It was built in the fifteenth century, but was enlarged and disfigured in much more recent times. The façade is both ordinary and heavy in appearance, while the *patio* is really a surprising work. On the right hand of the entrance is a spacious hall, facing another of less dimensions, which forms the entrance from the exterior. From this a staircase leads to the graceful gallery, surpassing in boldness many constructions in iron. The columns are of basalt, six inches in diameter, and in section are formed by four semicircles; these are spaced at distances of six feet six inches, and are 16½ feet high. The court is formed by six arches on the side of the staircase and on that opposite to it, while the other two sides have each seven arches. The staircase has a landing at the top of the flight, shown in the drawing, before entering the gallery, and this landing is not encumbered by the angle column, its duty being fulfilled by concealed constructions. It is to be regretted that M. Diebitsch was not able to explain the mode in which this was contrived. The width of the gallery over the entrance door is 6 feet 6 inches, and that of the other three galleries is 20 feet 9 inches. Doorways lead from the galleries into a small chapel, the offices of the municipality, and (by the door under the staircase) into a second and a third court. In this last are flowers, orange-trees, and a fountain, above which is seen the small campanile attached to the building. From the second court entrance is obtained to the great council chambers and courts of justice, which are adorned with very pretty coffered ceilings of woodwork, designed in the *style Arabo-Gothique*.

COURT. (Syracuse.)
(Plate LXXXIX.)

The court or quadrangle of the house in the Via Amalfitania, at Syracuse, is one of the examples of that picturesque effect which very simple means at the disposal of the architect can produce, when rightly applied.

ECCLESIASTICAL SCULPTURE.
Plate XCIII.

The group, from the Campo Santo, of Charity crowned as the Queen of the Cardinal Virtues, with Justice, etc., around her feet, is supposed to have been intended for a similar base to a pulpit, as that shewn in Plate xciv; and is attributed to Giovanni Pisano.

FOUNTAIN.
(Plate LXXXII.)

The example called the Fontaine de la Paix, in the place S. Sulpice, at Paris, bears more the character of a tomb, in the usual style of French classicism, of which it is one of the best exponents. It was designed by Destournelles, as given in his *Grands Prix de l'Architecture*, but executed and altered by his successor, Voinier. The other examples are specimens of the originality and beauty which may be displayed in the designs for such subjects.

GARDEN.

(Plate LXXIX.)

The Isola Bella is situated in the midst of the plantations (*bosquets*) of the Boboli Gardens at Florence. Two alleys conduct by a gentle slope to the amphitheatre; they are ornamented with marble bases and statues, and bordered on each side with waterfalls half concealed by laurels and evergreens. This supply of water runs into the large basin surrounding the island; and this island, about two hundred feet long by one hundred and fifteen wide, is decorated around its margin with orange-trees and a marble balustrade. At the head of each of the bridges to the island are two pair of wreathed, or rather spirally-fluted, marble columns, with gates, and statues on pedestals. In the centre of the whole composition stands a *vasque* or tazza-formed pedestal, made of granite and surmounted by a colossal statue of Oceanus, below which are three other figures of less dimensions, representing the Nile, Euphrates, and Ganges. Around the pedestal, which supports the large tazza, a circular seat has been arranged, so that the visitor resting there finds himself surrounded by the water, which escapes from the tazza, and sheltered by the great vase, which serves as a canopy. The bosquets or thickets, surrounding the basin, are cut into semicircular niches, containing seats of the same form. The whole composition, to which visitors have always given their warmest admiration, on account of the taste visible in the general arrangement, and the care displayed in the details, was originally designed by Il Tribolo, but finished by Giorgio Vasari; the statues were by Giovanni di Bologna.—Famin and Grandjean, *Architectura Toscana*, fol., Paris, 1815, Plate 8.

The road from Monreale to Palermo was formerly a grand and wide avenue. It is lined with palazzi and villas, of little merit as works of architecture, but very picturesque; among them occur at short intervals fountains, such as that shown on this plate, to which it belongs as a species of garden decoration. The wing walls originally contained a bed of flowers, which would take away the present appearance of its being a seat. Although several of these existed before 1760, yet the number added by Monsignore Testa, archbishop of Monreale, may give him the credit of thus usefully embellishing this beautiful road, by this astonishing series of fountains, which ends at the southern gate of Palermo, called Porta Nuova. Houel. *Voy. Pitt.* Paris, 1782, Plate 37.

GENOA.

(Plate LXXX.)

The Strada Nuova was the idea and plan of the architect Galeazzo Alessi, between 1552 and 1572, who built all but two of the thirteen edifices in this street, which, with their companions and rivals, give to Genoa la Superba the supremacy in the architectural beauty of varied and noble edifices, over every other city. The building on the left hand of the sketch (*i.e.*, the right hand of the spectator), is the Palazzo Doria Tursi, now the Jesuits' College; the architect was Rocca Lurago, of Como; beyond this is the Pal. Ragio. On the opposite side are the Palazzi Serra, or del Sole, and Brignole Sale (or Pal. Rosso), with another of the Brignoli in the background. The street is narrow, being about twenty-five feet wide, and paved with flags only.

ORGAN.

(Plates LXXVII, LXXVIII, XCI, XCII.)

The magnificent organ in the church of S. Mary, at Lubeck, may be presumed to have been built at the time, when most of its gorgeous embellishment was added, namely, in the year 1518. Master Barthold is named as its constructor. Although repaired from time to time, it seems that the general appearance suffered no alteration until 1640, in which year the ornamental case, *i. e.* the part at the bottom of the small organ (Plate xcii), was added. In the year 1706, the whole church was repaired, and the *Senatores*, who directed the works, placed their coats of arms below the organ and case; of these five coats, only one (that of Fuechting, at the top of Plate lxxvii) belongs to the year 1640; the inscriptions beneath the heraldic insignia are no longer legible, but seem to have contained the names of the senators. The height of the vault of the church is about 123 ft. from the pavement. On each side of the organ are two very large pipes, belonging to it, and fixed to the nearest pillars. The dotted lines, on the left hand of the plate, show how much of the organ is concealed by the projection of the pipe and pillar. The coat of arms on each side of the upper part of the small organ are those of the "Free Hanse Town" Lubeck, the coat of the empire being on the right hand, and that of the town itself, "*party per fesse, argent* and *gules*", on the left hand. They are drawn to a large scale, one at the top of Plate lxxvii, the other in Plate xci. The position of the detail given in Plate lxxviii will easily be recognized, by the angel and the figure (probably meant for the monk Guido, as it does not seem to be one of the saints). The coat of Lubeck affords the means of indicating the situation of the detail given in Plate xci; and the contents of Plate xcii consist, beside the centre part of the small organ, of the figure of King David, the panel between the two half-length figures, and of the ornament at the base of the large organ.

PULPIT.

(Plate XCIV.)

The building commonly called Giotto's Chapel, at Padua, dedicated to Sta. Maria dell' Annunciata (and often called Sta. Maria dell' Arena, from its standing within the precincts of the Roman amphitheatre), was built by Enrico Scrovigno, about the year 1303. At this period, Giotto, then young, was living at Padua, and Scrovigno employed him upon this fabric; the author of the *Handbook for Italy*, declares that the unity of design apparent in the chapel and the paintings, resulted from both being designed by the same hand. The octagonal pulpit in the cathedral at Siena is of white marble, supported by eight columns, four of which rest upon lions playing with their cubs, and surround a central column, the base of which is shown separately. The whole is one of the most remarkable works of Niccola da Pisa, with the date 1226. The Last Judgment, represented in one of its bas-reliefs is considered to be one of the finest productions of this illustrious artist.

WINDOW.

(Plate LXXXIII.)

This plate of illustrations consists entirely of examples collected in Catania, and indicates the style of architecture prevalent about the year 1700 in the south of Italy. With many defects, these windows suggest ideas, which may be translated by the architect into positive beauties.

WOODWORK.

(Plate XCV.)

These three examples of woodwork are, like the organ, from the church of S. Mary at Lubeck; and are fine illustrations of a style of ornamentation, of which the earliest marks are referred to the fourteenth century, but of which examples so luxuriant are hardly ever given in illustrated works. Even Heideloff, *Ornemens du Moyen Age*, 4to, Nuremburg, 1845, hardly shows a distinct example of such leafage; but from a drawing of the year 1437, and a stall dated 1488, may be easily deduced an approximation to the epoch, during which this ornamentation was cultivated in the German empire.

John W. Papworth.